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**IMPACTING STUDENT SLUMBER: AN ANALYSIS OF SELF-REPORT AND
PHYSIOLOGICAL DATA FOLLOWING A PSYCHOEDUCATIONAL
INTERVENTION**

by

Danielle N. Newman, B. S., M. S.

**A Dissertation Presented in Partial Fulfillment
Of the Requirements for the Degree
Doctor of Philosophy**

**COLLEGE OF EDUCATION
LOUISIANA TECH UNIVERSITY**

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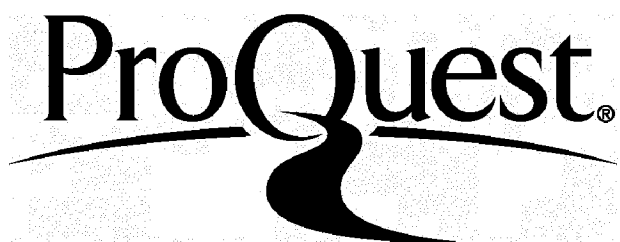
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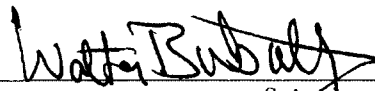
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We hereby recommend that the dissertation prepared under our supervision
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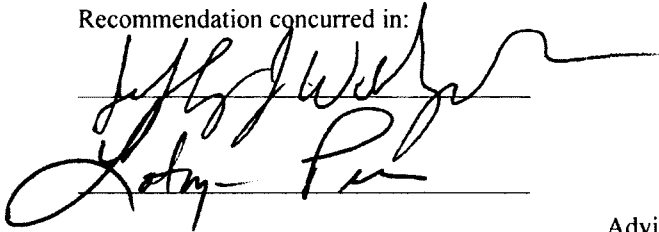
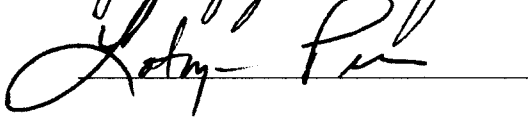
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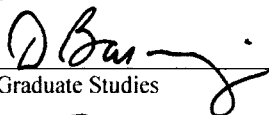
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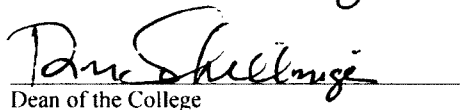



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ABSTRACT

Research shows that college students have extensive rates of sleep struggles, with up to 89% of college students reporting that they have moderate to severe difficulties with sleep (Buboltz, Brown, & Soper, 2001). Insufficient sleep has been linked to problems with academics (Kelly, Kelly, & Clanton, 2001; Taylor, Vathauer, Bramoweth, Ruggero, & Roane, 2013), mental health (Ghumman & Barnes, 2013; Horne, 1993; Manber & Chambers, 2009), physical health (Dahl & Lewin, 2002; Gailliot et al., 2007; Lyytikainen, Rahkonen, Lahelma, & Lallukka, 2011; Van Cauter, Leproult, & Plat, 2000), and a variety of other problems. Results pertaining to the suggested and successful treatment of sleep difficulties are unreliable (Brown et al., 2006; Calvert, 2012). Also, reliability of self-report data is questionable, which can lead to inconsistent outcomes (Forquer, Camden, Gabriau, & Johnson, 2008). Thus the purpose of this study was twofold. The first purpose of this study was to examine the effectiveness of a psychoeducational sleep intervention compared to a control group. The second purpose of this study was to examine the relationship between subjective and objective sleep data. A total of 87 participants attended all three phases of the study and completed pre and post measures assessing sleep quality, sleep hygiene knowledge and practices, insomnia symptoms, fatigue, and anxiety about sleep. Participants' subjective and objective sleep was also assessed. Results indicated no significant difference in sleep quality or sleep

length between intervention with participants' group. Interestingly, although the intervention significantly increased sleep hygiene knowledge in the treatment group, acquisition of information did not translate into increased sleep hygiene behaviors. Additionally, results indicated that there were not significant differences between participants subjective and objective sleep data. The implications and limitations of the study are discussed as well as suggestions for future research.

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Author Daniel N. Neuman

Date 06/30/2017

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CHAPTER ONE

INTRODUCTION

Sleep is essential to human life and functioning, with humans spending approximately one-third, or 25 years, of their lives asleep (Green, 2011). The amount and patterns of sleep a person experiences will have an effect on their health and ability to effectively handle illness and fatigue (Irwin et al., 1996; Meyer & Boll, 2014; Spiegel, Sheridan, & Van Cauter, 2002), cognitive abilities (Taylor, Bramoweth, Grieser, Tatum & Roane, 2013; Wyatt & Bootzin, 1994), academic performance (Chung & Cheung, 2008; Gaultney, 2010; Wong, Rowland, & Dyson, 2014), and mental health (Gregory & Sadeh, 2012; Krenek, 2006; Pilcher & Ott, 1998). Adequate sleep stems from interactions between environmental and biological factors (Wolfson & Carskadon, 2003). A lack of sufficient sleep is associated with extreme sleepiness, difficulty concentrating, nausea, and decreased motor control (National Sleep Foundation, 2006a). Sleep length and quality have continued to decline in society. Although shorter sleep duration is a trend that is now seen more frequently, it does not equate to decreasing the necessity of sleep and often causes pervasive sleep disruptions, resulting in inferior functioning (Wolfson & Carskadon, 2003). What occurs at night affects all aspects of the day, including the ability to learn, memory, mood, health, safety, energy, and performance (Marano, 2003).

According to the National Institute of Health (2012), sleep deprivation occurs when an individual does not get enough sleep and is typically consistent with getting less than six hours of sleep per night. Sleep deprivation is becoming a greater concern with each passing year. While the importance of adequate sleep has not changed, the amount of sleep individuals get per night continues to decrease. In 2009, the National Sleep Foundation found that one in five Americans were sleeping less than six hours per night, which is significantly lower than the eight hours recommended. Difficulties related to inferior sleep are a substantial concern within the college student population and affects the majority of students (Buboltz et al., 2001; Lund, Reider, Whiting, & Prichard, 2010). Research has repeatedly demonstrated extensive and pervasive sleep difficulties within the college student population (Bonnet & Arand, 2012, Buboltz et al., 2001) that results in decreased overall functioning and quality of life. Serious concerns about the nature and impact of inadequate sleep within the undergraduate population have been raised (Forquer et al., 2008).

Increased awareness of widespread difficulties with sleep has led to a variety of treatment options intended to increase sleep quality and length, thereby ameliorating the adverse effects resulting from insufficient sleep. However, types of interventions suggested for the treatment of sleep disturbances are not consistent and some are not well validated, while others have provided mixed results. For instance, multiple studies have suggested that stimulus control, an intervention to increase associations between the bedroom and sleep, is the most effective means of increasing sleep length and quality (Morin & Wooten, 1996; Murtagh & Greenwood, 1995), whereas others cite the empirical support for sleep hygiene (Hauri, 1993; Morin, Culbert, & Schwartz, 1994),

relaxation techniques (Bootzin & Perlis, 1992; Friedman, Bliwise, Yesavage, & Salom, 1991), psychopharmacological intervention (Ohayon et al., 1999), or other forms of treatment for sleep difficulties. In addition to varying suggestions, interventions that assess efficacy of various treatment modalities are also mixed. While some studies have found sleep hygiene interventions to have clinical support (Morin et al., 1994; Murtagh & Greenwood, 1995), others find that many participants show an increase in sleep hygiene knowledge without applying the knowledge to alteration of behaviors (Holbrook, White, & Hutt, 1994) and that increasing knowledge alone is insufficient to impact an individuals sleep (Morgenthaler et al., 2007). The inconsistent results and modalities of treatment can make the treatment of sleep disturbances increasingly difficult. Also, developmental level, lifestyle characteristics, and other personal, environmental, and biological factors will impact an individuals' ability to attain appropriate sleep length and sleep quality.

Statement of the Problem

College students are a subset of the population found to have significant sleep difficulties, with up to 89% of college students reporting sleep complications ranging from moderate to severe (Buboltz et al., 2001). College students represent the majority of the population of young adults, with over 66% of high school graduates attending college (United States Census Bureau, 2013). It is recommended that young adults sleep between seven and nine hours per night, but 71% of college students report getting less than eight hours of sleep per night. (Bonnet & Arand, 2012). In a study by Lund, Reider, Whiting and Pritchard (2010), nearly 70% of college students identified difficulties with poor

sleep quality, inadequate sleep, and/or unstable sleep patterns. In addition, they found that 20% of college students would neglect sleep all night at least once a month.

College students consistently report getting less sleep than they require and that their quality of sleep is inconsistent and generally low (Carney, Edinger, Meyer, Lindman, & Istre, 2006; Gomes, Tavares, & de Azevedo, 2011; Manber, Bootzin, Acebo, & Carskadon, 1996). Students with significant sleep disturbances report fatigue, depression, tardiness, mood dysregulation, lack of motivation, and increased rates of dropout (Dahl & Lewin, 2002; Manber, et al., 1996; Wolfson & Carskadon, 1998). This stresses the importance of interventions aimed at impacting college students' sleep patterns to allow them to be successful and have greater life satisfaction. The impairments noted due to sleep deficits are astounding. In fact, a 2014 Public Broadcasting Station article reported that loss of sleep causes the same impairments as binge drinking and chronic marijuana use, but were often overlooked in terms of evaluation and interventions on college campuses (Jacobson, 2014). Also within the same article, Roxanne Prichard, an associate professor of psychology and investigator, was cited as making the statement that "addressing sleep problems early in a student's career can have a major economic benefit through increased retention."

Sleep habits develop during adolescence and are one of the first routines to suffer when an individual begins college (Pilcher & Walters, 1997) as evidenced by inadequate sleep hygiene and poor sleep habits among college students (Onyper, Thacher, Gilbert, & Gradess, 2012; Vela-Bueno, Fernandez-Mendoza, & Olavarrieta-Bernardino, 2009). Nearly 70% of college students report sleep problems (Hicks, Fernandez, & Pelligrini, 2001) and nearly 60% of college students report poor sleep quality and frequent reliance

on alcohol and over-the-counter or prescription sleep medication to alter their sleep-wake patterns (Lund, et al., 2010). Insufficient sleep frequently results in inability to maintain attention or concentration, poor performance on cognitive and physical tasks, and improper regulation of emotions (Cote et al., 2009; Trockel, Barnes, & Egget, 2000). In addition, students will struggle to meet demands of daily life, resulting in increased procrastination and difficulties managing the demands of their academic and personal lives (Yazaki, Shirakawa, Okawa, & Takahashi, 1999).

Interventions targeting the college population try to alleviate the growing issues related to sleep problems and associated consequences, but results are often mixed (Brown, Buboltz, & Soper, 2006; Calvert, 2012). There is currently no “gold standard” for treating sleep difficulties in college students due to the inconsistency of results regarding effective interventions. This study will address these concerns by evaluating a psychoeducational sleep intervention aimed at improvement of sleep length and quality in college students. Additionally, the interaction of sleep beliefs and sleep anxiety on the outcome of the intervention will be assessed in order to explore variables that may prevent individuals from achieving more consistent benefits from the intervention.

Justification

In the United States, insomnia alone costs approximately 63.2 billion dollars annually, with only one third due to absenteeism from work or school and the other two thirds due to decreases in productivity (University of Bergen, 2012). Although there have been multiple interventions aimed at this subset of the population (i.e. Calvert, 2012; Quan, Anderson, & Hodge, 2013), the literature regarding physiological, objective

data of sleep in addition to self-report measures is sparse. Also, while many interventions incorporate sleep hygiene awareness and practices, research has shown that while many acquire knowledge of sleep hygiene, they fail to result in significant implementation of sleep hygiene practices (Brown, Buboltz, & Soper, 2001).

As mentioned above, the vast span of factors negatively impacted by insufficient sleep and the aversive outcomes associated are well documented. By increasing sleep length and quality, many of these negative outcomes can be ameliorated, including mental health problems, concentration difficulties, and academic problems. Overall quality of life improves when sufficient sleep is achieved and those getting the recommended seven to eight hours of sleep at night have fewer medical problems and increased longevity (Bellec & Breslow, 1972; Frederick, Frederich, & Clark, 1988).

Present Study

The purpose of the present study is to evaluate the efficacy of a sleep intervention program on undergraduate college students through the utilization of self-report and objective measures and sleep. The Sleep Proficiency Excels with Awareness and Knowledge (SPEAK) program was adapted from the Sleep Treatment and Educational Program for Students (STEPS) program (Brown et al., 2006). The SPEAK program includes elements of sleep hygiene knowledge and practices, stimulus control, and cognitive factors that impact sleep. It serves to increase awareness of factors that affect sleep and the negative consequences associated with sleep deprivation as well as provide the knowledge and skills needed to acquire restorative and restful sleep.

Literature Review

The following is a general overview of pertinent information on sleep. Historical perspectives of sleep theories, sleep stages, and biological mechanisms of sleep are reviewed. Defining sleep and the prevalence of sleep disturbances are presented, followed by the consequences of inadequate sleep. Next, interventions to improve sleep are introduced, including those specifically aimed at increasing sleep length and quality in undergraduate college students. Finally, actigraphy use and efficacy are described.

Theories of Sleep

Repair and restoration theory. The repair and restoration theory states that short wave or NREM sleep allows for the physical restoration and repair of an organism, and that REM sleep is responsible for promoting restoration of the brain (Oswald, 1980) in addition to replenishing energy that was exhausted throughout the day (Shapiro & Flanigan, 1993). The repair and restoration theory has some empirical backing and maintains that the purpose of sleep is to restore physical, neurological, and psychological states and is necessary in order to allow cells to rebuild and grow (Hirshkowitz, Moore, & Minhoto, 1997).

Research has shown the important role sleep plays in neurological functioning and human growth. For example, researchers have found that human growth hormone release, which is responsible for cell growth and repair, occurs during NREM sleep. During the REM sleep phase, individuals reach their highest level of protein synthesis (Arch, Browman, Milter, & Walsh, 1988). Sleep neutralizes neurotoxins that build up throughout the day and returns levels of brain chemicals to optimal levels (Drucker-

Colin, 1979; Hartman, 1973). The repair and restoration theory also states that sleep length will increase when there is greater need for repair, which coincides with research showing that individuals typically have an increased duration of sleep after infection or illness (Frieze, 2008).

Adaptive or evolutionary theory. Sleep is vital to living organisms, providing periods of non-responding that promote the evolutionary need for species survival. Support for the evolutionary theory of sleep lies in the fact that animals lower in the food chain sleep for shorter periods of time than those that are more predatory by nature. For example, animals that graze for food will sleep for approximately three hours at a time whereas cats, which are seen as more predatory, will sleep for longer periods (Webb, 1979). Additionally, sleep allows for the conservation of energy, which can be adaptive. Sleep will occur at times in which there is a greater chance of being attacked or there is a lack of resources needed for survival. Animals will experience greater levels of activity when they are least likely to become prey and have greater chances of being a predator in order to meet their needs (Siegel, 2009).

Examples of evolutionary sleep have been researched in different types of animal species. Mammals have sleep states ranging from consistent activity to hibernation. For example, animals that cannot travel extensive distances will hibernate through the subzero winter season in order to survive. During the hibernation period, body temperature may be reduced to temperatures as low as -3° Celsius and cessation of most cortical and neuronal activity occurs in order to decrease responsiveness and conserve energy (Swoap, 2008). Interestingly, another evolutionary feature of sleep is that although it allows for drastic reductions in arousal, the brain still processes information

that is relevant for survival, such as a mother being able to sleep through a thunderstorm, but waking to the sound of her child (Kennedy et al., 1982; Maquet et al., 1990; Nofzinger et al., 2002). Sleep duration will also vary by species for survival. For example, lions will sleep for longer periods and sleep more deeply, but giraffes, which are prey for lions, have one of the lowest sleep durations of any species and are unable to sleep deeply in order to survive (Siegel, 2005).

Information consolidation and memory. There is significant evidence that sleep plays an essential role in the consolidation of human memory, including retention of declarative memories (Ellenbogen, Hulbert, Stickgold, Dinges, & Thompson-Schill, 2006; Ellenbogen, Payne, & Stickgold, 2006; Grosvenor & Lack, 1984; Plihal & Born, 1997; Smith & Lapp, 1991), procedural memories (Buchegger, Fritsch, Meier-Koll, & Riehle, 1991; Karni, Tanne, Rubenstien, Askenasy, & Sagi, 1994), and recently formed episodic memories (Rasch, Buchel, Gais, & Born, 2007). During the REM sleep stage, information from experiences of learning and memories are processed and incorporated into memory (Smith & Lapp, 1991).

Neuroscientists today believe that memory consolidation is not specific to a certain brain region, but occurs throughout the brain. Mechanisms for memory consolidation during sleep include transformation of declarative memory from dependence on the hippocampus to an independent state (Pavlides & Winson, 1989; Poe, Nitz, McNaughton, & Barnes, 2000; Squire & Alvarez, 1995). Memories are also encoded by strengthening the neural connections utilized while assessing new information, suggesting that memory consolidation and encoding occur through reactivation of synapses that strengthen their connection (Steriade & McCarley, 1990).

The basis of this theory lies in the fact that increases of neural connections occur during REM sleep and failure to attain REM sleep is associated with an inability to learn new information while awake (Wood, Bootzin, Kihlstrom, & Schacter, 1992). As memories change to an independent state, they may also slightly change content so that portions of episodic memory are abstracted into permanent semantic knowledge (McClelland, McNaughton, & O'Reilly, 1995).

Stages of Sleep

During sleep, people progress through a series of stages categorized by rapid eye movement (REM) and non-REM (NREM) sleep. The utilization of the electroencephalograph (EEG) allowed researchers to track brain waves and determine level of arousal to establish the stages of sleep (Green, 2011). Non-REM sleep, also referred to as slow wave sleep, has three stages and is characterized by an outward appearance of peaceful sleep, with little movement (American Academy of Sleep Medicine, 2005). During REM sleep, individuals exhibit rapid eye movements and twitching of extremities such as the legs and arms. As the sleep cycle progresses, individuals experience deeper sleep.

The first stage of sleep is a lighter stage of NREM sleep that occurs when an individual becomes tired and closes their eyes. This stage is experienced as drowsiness, which is characterized by theta waves (4-7 Hz), or relaxed wakefulness with subjects EEG showing alpha waves (8-12 Hz) (Carlson, 2004). While in stage one, some people may experience acute muscle spasms preceded by a sensation of falling (National Sleep Foundation, 2006a). People with insomnia spend significantly longer amounts of time in stage one sleep at night, resulting in a perception of wakefulness and an inability to

acquire the restorative sleep necessary to wake refreshed (Carskadon & Dement, 2000). Although it is the first sleep stage, it is more accurate to describe it as the period or stage of sleepiness, falling between wakefulness and slumber.

Stage two of NREM sleep occurs when the person is asleep, typically after about 10 minutes in stage one sleep for people without insomnia (Carlson, 2004). This stage includes light sleep and increased amplitude theta waves. Sleep spindles, bursts of high frequency activity (12-15Hz) lasting approximately half a second, are also seen on EEG readings during this stage (Green, 2011). K complexes, abrupt and sharp waves, in this stage help maintain a sleeping state (Bowersox, Kaitin, & Dement, 1985; Steriade & McCarley, 1990). Heart rate and body temperature decreases during this stage of sleep (National Sleep Foundation, 2006a).

Stage three is called slow wave sleep and begins after approximately 10 to 25 minutes in stage two sleep (Carskadon & Dement, 2000). This stage is dominated by delta waves (1-4 Hz) that are high amplitude and slow (Green, 2011). Sleep spindles are infrequent. Blood pressure has decreased, breathing slows, and body temperature continues to drop during this stage. The slow wave sleep experienced in this stage is the deepest level of sleep (Carlson, 2004). It is extremely difficult to awake those in slow wave sleep and if woken, they will likely display symptoms of confusion and fatigue (National Sleep Foundation, 2006a). The progression from drowsiness to the end of stage three takes about 75 minutes, at which time the person will go back to stage two of NREM sleep before entering the REM sleep stage (Carlson, 2004).

The results of EEG in REM sleep shows rapid and desynchronized brain activity, similar to the patterns seen in individuals that are awake (National Sleep Foundation,

2006a). In addition to increased brain activity, loss of muscle tone, increase heart rate, and increased blood pressure occur (Green, 2011). REM sleep is also referred to as paradoxical sleep due to the brain waves present when awake, but the brain paralyzes muscles to protect individuals from self-injury or acting out dreams that may occur (Calvert, 2012). Heart rate and blood pressure increase during this stage and dreaming occurs (National Sleep Foundation, 2006a).

After 15 to 20 minutes in REM sleep, a person will transition back to stage two NREM sleep and repeat their progression through the sleep stages (Green, 2011). Individuals will progress through the stages several times throughout the night, with each cycle of NREM and REM sleep lasting approximately 90 to 110 minutes, which averages to five cycles per night (Green, 2011). Although the first cycle of REM sleep may only last minutes, the amount of time spent in REM sleep increases with each cycle. By morning nearly all sleep is in stages one, two, and REM. This means that the longest stages of REM sleep occur during the last third of the night, which is around six to seven and a half hours of sleep (Carskadon & Dement, 2011).

The time spent in REM sleep is heavily influenced by age and development, with adults needing less REM sleep than infants and small children (Carskadon & Dement, 2000). As reported by the National Sleep Foundation (National Sleep Foundation; 2006b), on average, adults of all ages require seven to nine hours of sleep per night whereas teenagers need approximately 9.5 hours of sleep per night and infants need to acquire about 16 hours of sleep per day. In addition to sleep duration, it's important to note that longer sleep equates to more time spent in REM sleep since the length of the REM cycle increases as time spent asleep progresses. Generally, adults spend 20-25% of

time asleep in the REM cycle while newborns spend about 50% of their sleep time in REM sleep (National Sleep Foundation, 2006b).

Physiological Process of Sleep

The sleep-wake cycle is characterized by approximately eight hours of nocturnal sleep and 16 hours of conscious wakefulness. This cycle is controlled by two internal mechanisms: Homeostatic sleep drive and circadian rhythms. Homeostatic sleep drive will intensify sleepiness as the day goes on regardless of day or night whereas the circadian rhythm promotes wakefulness during the day and sleep at night (National Sleep Foundation, 2006a). If one or both of these mechanisms are altered, sleep difficulties ensue.

Homeostatic sleep drive. Homeostasis is the process that allows the body to maintain a constant internal state including a person's blood pressure, core body temperature, and amount of sleep each night. Homeostatic pressure builds throughout the day and is dependent upon how long an individual is awake and their activity level (Marano, 2003). Upon waking in the morning, the homeostatic sleep drive begins to accrue and peaks in the evening when individuals are going to sleep. Sleep is a homeostatic process with restorative effects on the brain by promoting neurological activity and reorganization of synapses (Hobson, 2005; Saper, Scammell, & Lu, 2005; Weinger & Ancoli-Israel, 2002) that aligns with the restorative theory of sleep.

The neurotransmitter adenosine may be involved in the homeostatic sleep drive (National Sleep Foundation, 2006a). Adenosine inhibits the basal forebrain, the brain structure associated with maintenance of arousal or alertness (Porkka-Heiskanen, 1999). While awake, levels of adenosine rise throughout the day and peak in the evening. Then

it increases a person's sleepiness. Certain substances, such as caffeine, will temporarily block adenosine receptors, thereby lowering the person's need for sleep for a period of time. While asleep, the body decreases levels of adenosine, which promotes conscious arousal and awakening (Porkka-Heiskamen, 1999).

Sleep is primarily controlled by the homeostatic sleep drive. When a person does not sleep all night, homeostatic processes will continue to stimulate sleep and will prompt the body to ameliorate the sleep debt in order to avoid negative consequences associated with sleep deprivation (National Sleep Foundation, 2006a). This aligns with the idea of the rebound effect in which individuals deprived of REM sleep will spend longer amounts of time in REM sleep (Dement, 1960). Although the homeostatic sleep drive plays an important role in sleep, it is not the sole factor in maintaining adequate amounts of sleep.

Circadian rhythms. Circadian rhythms occur over a 24-hour span and are controlled by a person's endogenous pacemaker, commonly referred to as their biological clock. The circadian rhythms are typically maintained through synchronization with information from the outside world, especially day and night. Some circadian rhythms are used to promote sleep at night and wakefulness during the day. Examples of bodily functions controlled by circadian rhythms include fluctuations in body temperature, hormone levels, and sleep (National Sleep Foundation, 2006a). While all living organisms have their own biological rhythms, humans are unique in that they do not always allow biology to guide behavior and will fight it, ingesting substances to stay alert, cognitively overriding to stay up late to complete a paper, or missing a night of sleep (Green, 2011).

The most well-known circadian rhythm is the sleep-wake cycle. During a 24-hour time period, many things occur physiologically in an attempt to keep an individual on a specific pattern/schedule. One example is that a person's body temperature peaks in the afternoon and then decreases. This decent may promote sleep. Body temperature will reach its lowest point in the early morning. A rise in temperature is associated with waking in the morning (Green, 2011). The circadian rhythms are ongoing cycles that continue throughout the night.

Studies have found key brain features associated with maintaining and controlling a person's circadian rhythm. Stephan and Zucker (1972) studied the outcome of damage to the suprachiasmatic nucleus (SCN), part of the hypothalamus, to determine its function in sleep. Their results showed that the SCN played a vital role in controlling biological rhythms including the sleep-wake cycle, release of the stress hormone corticosterone, and eating and drinking behaviors. When the SCN was damaged, subjects were found to get the same amount of sleep and progressed through the sleep stages as normal, but their sleep-wake cycle was unable to synchronize with the outside environmental cues of light and dark.

Light is the most important synchronizing agent to the external environment for humans (National Sleep Foundation, 2006a). The retinohypothalamic tract in the optic nerve sends information relating to the amount of light on the retina to the SCN. This information is used to synchronize the biological circadian rhythm to the environmental cues of light and dark. When the retinohypothalamic track relays information about the amount of light, neurochemicals in the SCN, including melatonin, will alter activity in response.

Melatonin is a hormone secreted by the pineal gland that affects the sleep-wake cycle by promoting sleep and is used by the body to regulate the circadian rhythm. Typically, two to three hours before an individual's typical bed time the body releases melatonin to decrease brain activity and promote sleep (Dijk & Cajochen, 1997). Melatonin levels decrease as morning comes, resulting in alertness and wakefulness (Haimov & Lavie, 1996). The amount of melatonin released is monitored by the interaction of the pineal gland with the SCN and increases during hours of darkness and decreasing during daylight (Green, 2011). Some individuals with sleep difficulties will consume melatonin at night to promote sleepiness, which can have hypnotic effects (Anton-Tay & Diaz, 1971; Cramer, Rudolph, Consbruch, & Kendel, 1974; Waldhauser, Saletu, & Trinchard-Lugan, 1990). In addition to its role in the circadian rhythm of sleep, melatonin plays a role in body temperature and the release of other hormones such as the human growth hormone (Green, 2011).

Delayed Sleep Phase Disorder

This is a circadian rhythm sleep wake disorder in which the individual's sleep-wake cycle is inconsistent with what is needed for daytime functioning (Green, 2011). Those with delayed sleep phase disorder (DSPD) are frequently unable to fall asleep at their desired times, meaning they often cannot fall asleep prior to one to three a.m., but sleep soundly through the night once they have fallen asleep (Green, 2011). Due to the chronic difficulty with sleep initiation, individuals struggle to wake at the appropriate times in the morning (American Academy of Sleep Medicine, 2005). When individuals force themselves to wake and attend classes or other obligations in the morning and they have not had sufficient sleep, difficulty with waking and appropriately functioning occur.

Among adolescence and emerging adulthood, DSPD is the most frequently seen disorder, with approximately 16% affected (American Academy of Sleep Medicine, 2005; Lovato, Gradisar, Short, Dohnt, & Micic, 2013; Pelayo, Thorpy, & Govinski, 1988; Saxvig, Pallesen, Wilhelmsen-Langeland, Molde, & Bjorvatn, 2012) and peaks around the age of 20 (Roenneberg et al., 2004), when many are attending college. One explanation for this increase of DSPD is the variability of schedules during this time in life while attempting to integrate class schedules, work, and the transition to a new setting with increased responsibilities.

The pattern of sleep associated with DSPD results in chronic sleep deficiency, which negatively impairs various sectors of a person's life. Rajartnam, Licamele, and Birznieks (2015) evaluated potential risks for developing DSPD and found those with increased risk for DSPD have significantly greater likelihood of daytime deficiency including absenteeism from work or school, decreased productivity, and inability to adequately function in their roles at school, work, home, or social sectors. In their sample, those most at high risk for DPSD were between the ages of 18-30 (66.1 % of their sample).

In addition to risk factors, those diagnosed with DSPD report difficulties in everyday living. Academic performance decreases due to fatigue and excessive sleepiness during the day (Thorpy, Korman, Spielman, & Glovinsky, 1988) and rates of aggression, disciplinary issues, and depressive symptoms increase (Kripke et al., 2008; Thorpy et al., 1988). They are also more likely to use sedative or hypnotic drugs and be involved with psychotherapy or behavioral interventions (Czeisler et al., 1981). Those with DSPD also have high comorbidity with a depression diagnoses (Regestein & Monk,

1995) and are more likely to experience financial, marital and employment problems (Alvarez, Dahlitz, Vignau, & Parks, 1992).

Sleep Length and Quality

Sleep length. Sleep length is the total number of hours an individual sleeps per night. The National Sleep Foundation recommendation for sleep duration varies by age, with school age children (age six to 13) receiving nine to 11 hours of sleep, teens (age 14 to 17) sleeping eight to 10 hours of sleep, and adults seven to nine hours (Hirshkowitz, 2015). Despite these recommendations, 71% of adults acquire less than eight hours of sleep during the week (National Sleep Foundation, 2005). Many studies have attempted to determine an optimal amount of sleep for individuals. In many studies of adults, the conclusion has been reached that there is not an ideal amount of sleep and that it instead is dependent on individual needs (Ferrara & De Gennaro, 2001).

Beginning around the age of 14, adolescents show individual differences in the amount of sleep required feeling fully awake during the day (Mercer, Merrit, & Cowell, 1998). Individual differences in the amount of sleep continue throughout the lifespan, although there are recommended ranges of sleep duration for optimal performance and avoidance of negative consequences. In fact, people of all sleep length report sleep difficulties (Grandner & Kripke, 2004), indicating that sleep length does not always relate to perceptions of adequate and sufficient sleep. The National Sleep Foundation (2015) identified that for young adults age 18 to 25, getting less than five hours of sleep or more than 12 hours of sleep is not optimal.

A study by Taub and Berger (1976) investigated the impact of sleep length on performance and mood. Participants completed a 45-minute vigilance task, mood

adjective checklist, and an additional short task that was paced by the experimenter. All tasks were completed three times per day (upon awakening, mid-day, and evening) after electroencephographic (EEG) monitoring of sleep for five consecutive nights. In addition to the control group, experimenters manipulated the amount of sleep attained at night by three hours in one of four ways: extending sleep length, reducing sleep length, delaying onset of sleep, or initiating sleep onset earlier. For example, those in the sleep reduction group slept three hours less than their baseline and those in the advanced onset sleep group initiated sleep three hours prior to their normal bedtime. Results showed that all four groups with manipulations in sleep length exhibited impairments in performance and decreased subjective attention and arousal. Notably, their results indicated that changes in an individual's circadian rhythm results in decreased ability to function effectively and is largely dependent on their established sleep patterns the total amount of time spent asleep.

Lund et al. (2010) found that one out of four of college students get less than 6.5 hours of sleep per night and that only about 29 percent of college students get eight or more hours of sleep per night. If individuals are unable to acquire the appropriate amount of sleep, their brain and body cannot complete all necessary tasks that occur during sleep, including muscle repair, memory consolidation, and hormone levels, especially those responsible for hunger and growth (National Sleep Foundation, 2015).

Dewald-Kaufmann, Oort, Bogels, and Meijer (2013) evaluated differences in daytime functioning of adolescents based on chronic sleep reduction and sleep duration. A total of 799 participants ranging between 11 and 19 years old participated. Individuals that report chronic sleep reduction and those with shorter sleep duration had the most

significant impairment in daytime functioning including depressive symptoms, attentional problems, achievement motivation, teacher-child relationships, academic self-concepts, and school performance. Specifically, individuals with chronic reductions in sleep exhibited more depressive symptoms and attentional impairments. Participants reporting infrequent instances of shorter sleep length were most notably impacted in the areas of achievement motivation and attention.

Dewald-Kaufmann, Oort, and Meijer (2013) researched differences in adolescents' ability to function during the day based on the duration of sleep and chronic sleep reduction. Researchers first measured adolescents sleep length and the frequency of insufficient sleep. Participants on either extreme were included in the analysis so that four groups were analyzed: Chronic sleep reduction-low, chronic sleep reduction-high, sleep duration-shortest, and sleep duration-longest. Individuals with chronic reductions in sleep and those with shorter sleep length reported greater levels of daytime impairment including depressive symptoms, difficulty with attention, decreased achievement motivation, increased interpersonal difficulties, decreased academic self-concept, and poorer school performance. Those with low rates of chronic sleep reduction and those with sufficient sleep duration reported significantly fewer daytime impairments. The results indicate that sleep length can significantly impact various aspects of daily functioning.

Sleep duration is also associated with impaired functioning. Devore et al. (2014) examined this relationship in midlife and later life. In midlife, participants with both shorter or longer than seven hours of sleep per night reported lower levels of physical activity. In later life, those with more or less than a seven hour sleep duration had

increased rates of obesity and decreased physical activity. Also, in later life women with the shortest sleep durations had increased rates of living alone compared to those getting seven hours of sleep. The relationship between sleep length and cognitive functioning was also evaluated and indicated a U-shape, with those reporting fewer than five hours of sleep or more than nine hours of sleep performing significantly worse on cognitive performance in both mid and later life, although the relationship was more pronounced in later life than midlife. Additionally, when evaluating differences in sleep duration over time, individuals reporting a difference of two or more hours of sleep per night between midlife and later life had significantly greater cognitive deficiencies.

Lehto and Uuistalo-Malmivaara (2013) assessed the impact of short sleep duration on attention and symptoms of depression in children; 432 fifth graders provided information about sleep duration on weekdays and weekends as well as problematic sleep behaviors, attention, depression symptoms, and daytime sleepiness. Even in students approximately 11 years old, there were significant differences in sleep duration on weekdays versus weekends, with participants sleeping an average of more than an hour longer per night on weekends. Contrary to the researchers hypothesis, student sleep duration was weakly associated with daytime sleepiness. Further, results indicated that both attentiveness and indicators of depression were related to unfavorable bedtime behaviors and daytime drowsiness, but not to sleep duration.

Sleep quality. Sleep quality is the measure of restorative sleep (Calvert, 2012) and includes length of time in REM sleep, wakefulness in the morning, and how satisfied individuals are with their sleep (Pilcher, Ginter, & Sadowsky, 1997). It is possible for someone to have good sleep length and poor sleep quality or vice versa. For example, if

an individual sleeps for eight hours at night but wakes frequently, they may not experience high quality, restorative sleep. Sleep quality is problematic for college students, with as many as 89% reporting sleep difficulties ranging from mild to chronic (Buboltz et al., 2001). Lower sleep quality is associated with multiple areas of functioning, including decreased motor reaction time, poor vigilance, inability to concentrate on the task at hand, and to critically evaluate a problem (Taub, 1980).

Forquer, Camden, Gabriau and Johnson (2008) examined the sleep patterns of college students at a public university. Their study included a total of 313 students and the results indicated that more than 33% had difficulty falling asleep, meaning it took longer than 30 minutes, 43% woke up multiple times throughout the night, and more than 33% described feeling fatigue throughout their day. This study demonstrates poor sleep quality experienced in college students.

Stenzel (2015) identified multiple factors that are negatively associated with sleep quality in college students. One hundred and thirty-four students participated in the study, with the top four behaviors affecting sleep quality being: (1) school work/studying, (2) mental issues related to stress, anxiety, and depression, (3) drugs, alcohol, and caffeine stimulants, and (4) going out with friends or partying. Although participants did not report significant difference in sleep length between weekdays and weekends, 77% reported sleep onset and rise times were later on weekends, which supports research indicating higher prevalence rates of DSPD in college students. Although sleep length was equivalent, sleep quality is likely to be disrupted by changes in sleep times.

Buboltz et al. (2001) examined sleep quality among college students. In their sample, an astounding 73% of students reported moderate sleep difficulties and 50%

reported that they felt tired and not refreshed upon waking in the morning. In addition, 15% of individuals described symptoms consistent with poor sleep quality and only 11% reported symptoms consistent with good sleep quality. The authors identified that college students experience greater difficulties with sleep quality than the average adult population.

In 2009, Buboltz et al., examined sleep patterns among 742 undergraduate students from three different universities. Participants completed self-report measures of sleep quality and sleep habits; 88.5% of students reported at least occasional sleep difficulties and more than half of participants reported symptoms of sleepiness upon rising in the morning. Differences between the onsets of sleep and wake times on weekdays and weekends were also evaluated. Results indicate that on weekends, students sleep onset was approximately an hour later than during the week and wake times were an average of two hours later than weekdays. This pattern of sleep coincides with delayed sleep-wake phase disorder (DSPD), a circadian rhythm disorder in which individuals experience exaggerated sleepiness in the morning and difficulty falling asleep due to alteration in schedules.

Sadigh, Himmanen, and Scepensky (2014) found a relationship between sleep quality and anxiety. One hundred female college students participated in a study to evaluate the relationship between trait anxiety and insomnia. The prevalence of insomnia in the sample was 50%, which is higher than the general population. College student's expressed increased stress that impacted sleep quality, particularly their inability to fall asleep, stay asleep, and attain restorative sleep. The negative correlation between trait anxiety and sleep quality and disturbances in sleep was pronounced, indicating that this is

a serious concern for U. S. college students. Also, results showed that the longer it takes to fall asleep, the greater the chance of having sleep disturbances throughout the night.

Adams and Kisler (2013) evaluated the relationships among sleep quality, technology use, depression, and anxiety. Their results showed that poor sleep quality is predicted by technology use after the initial onset of sleep for the night, meaning that after individuals have gone to sleep they will wake to respond to text or phone calls, check their technology devices, or go on the Internet or social media sites. Results also showed that poor sleep quality predict an individual's anxiety and depressive symptoms. Further analysis showed that sleep quality mediated the relationship between waking to use technology devices after the initial onset of sleep and mental health concerns relating to depression and anxiety. Sleep quality is significantly impacted by the use of technology such as mobile phones after going to bed for the night and may include waking to answer a phone call, respond to a text, or check social media sites. When individuals are not achieving restorative sleep, they will experience difficulties with emotion regulation and other psychological health concerns.

Sleep in College Students

The prevalence of sleep difficulties, including DSPD, among college students is a significant problem (Bonnet & Arand, 2012, Buboltz et al., 2001). Emerging adults (18 to 25 years old) should obtain seven to nine hours of sleep a night (National Sleep Foundation, 2015). College students have a greater need for sufficient sleep as they navigate a series of new experiences, responsibilities, and challenges (Dahl & Lewin, 2002; Loessel et al., 2008), yet many students get less than eight hours of sleep per night (Bonnet & Arand, 2012) and report significant sleep difficulties (Buboltz et al, 2001;

Lund et al., 2010). In fact, the American College Health Association (2007) reported that 71% of college students feel they are not well rested for at least five of the past seven days and that they do not get adequate amounts of sleep.

Students frequently identify sleep difficulties, but are often unaware of why they are struggling to sleep at night. When examining negative behaviors college students perceive to be responsible for their sleep difficulties, 17% of students identified work/studying; 13% stated the cause was due to mental health issues; 12% said their sleep difficulties were a result of drugs, alcohol, or caffeine, and 10 % said their sleep problems were due to partying with friends (Stenzel, 2015). Many factors are likely to contribute to the epidemic of sleep disruptions in college students.

Galambos, Dalton, and Maggs (2009) studied changes in sleep quantity and quality during students first semester of college. Participants were asked to complete at least one web-based assessments per day for 14 consecutive days during one of four periods of time during the semester. Although students slept an average of seven hours and 37 minutes on weeknights, results support previous findings of increased DSPD symptoms (Roenneberg et al., 2004), with students sleeping an average of 49 minutes longer on weekends than weekdays. Evaluation of several factors showed that sleep quality was negatively impacted by school assignments or if they were being evaluated the following day. Sleep quality was greater in participants with more positive affect and those that reported spending time with friends, although this was not true if alcohol was consumed while socializing. Students also reported increased sleep length and sleep quality on weekends and described that anxiety and negative mood throughout the day did not significantly impact the ability to attain adequate sleep.

College is a transitional time, which is likely to result in a period of increased disturbances in sleep. There are significant concerns regarding the state of sleep in the college student population. In Forquer, Camden, Gabriau, and Johnson's 2008 study, participants reported waking at least once during the night (47% of the sample) and provided various reasons for rising, including hearing noise from others (41%), going to the restroom (40%), or having concerns and anxiety about something (33%). Of the 313 participants, half reported using sounds, such as fan or white noise, as sleep aides; 58% felt tired upon waking, and 33% woke feeling refreshed and energized, but became excessively tired during the day. These patterns of sleep described by college students highlight many areas of problematic sleep concerns. Variable sleep schedules, which contribute to DSPD, can cause significant impairments as well as fragmented sleep and misinformation regarding alleviation of symptoms, such as listening to music or television.

Factors Contributing to Poor Sleep in College Students

Many studies have demonstrated significant impairments in daytime functioning in those with shorter sleep duration and poorer sleep quality (Dahl, 1999; Meijer, Habekothé, & Van den Wittenboer, 2000; Meijer, Reitz, Dekovic, Van den Wittenboer, & Stoel, 2010). Research on sleep in college students has been ongoing for many years and has identified multiple variables that impact whether an individual is able to acquire necessary and restorative sleep and avoid preventable negative consequences. Sleep is mostly impacted by environmental and biological factors (Beersma & Gordijn, 2007), but college students have certain characteristics and experiences that are likely to heighten their difficulties with sleep.

Stress, anxiety, and mental health disorders. Sleep is especially important during transitional periods when individuals are coping with new challenges and facing new obstacles, such as the transition to college (Dahl & Lewin, 2002; Fuligni & Hardway, 2006; Loessl et al., 2008). Many young adults are leaving home for the first time and need to balance the demands of increased responsibility, autonomy, and time management needs, which can create anxiety. Students sometimes have difficulty coping with the transitional changes to college and are more likely to suffer from sleep disturbances and insufficient amounts of sleep (Buboltz, et al., 2001; Buboltz et al., 2009).

College students endorse prominent stressors that include finances, personal life, family concerns, academics, and environmental issues (Mendoza, 1981; Rocha-Singh, 1994). Individuals with higher stress levels typically get less sleep (Hudd et al., 2000) and report fragmented sleep (Mezick et al., 2009), poor sleep quality (Hall et al., 2008), and symptoms of insomnia (Gregory, Caspi, Moffitt, & Poulton, 2006).

There is a strong relationship between stress and insomnia (Morin & Espie, 2003). Brand, Gerber, Pühse, and Holsboer-Trachsler (2010) evaluated relationships between stress and insomnia in young adults. Results showed that insomnia was moderately associated with both perceived stress ($r = .5, p < .001$) and stressful events ($r = .43, p < .001$). Bernert, Merrill, Braithwaite, Van Orden, and Joiner (2007) found that academic stress and negative family events predicted an increase in insomnia scores. Another study by Lee, Wuertz, Rogers, and Chen (2013) found female students levels of stress were associated with sleep disturbances and daytime sleepiness. Pedersen (2012) evaluated types of anxiety and their impact on student sleep and found that, for women,

sleep was more likely to be disrupted by academic stress whereas for men, stress relating to their family was more likely to negatively impact sleep.

Minkel et al. (2014) evaluated the relationship between stress reactivity and sleep deprivation. Researchers assessed levels of cortisol, a hormone released during times of stress, and sleep. The results showed that participants cortisol levels when resting and when exposed to a stressor were significantly elevated in those that had not attained adequate amounts of sleep. In addition to sleep difficulties, increased cortisol levels have been associated with depression (Bogdan, Nikolova, & Pizzagalli, 2013) and obesity (Epel, Lapidus, McEwen, & Brownell, 2001; Tataranni et al., 1996).

Research on the relationship between stress and sleep was researched by Fernández -Castillo (2013) through the evaluation of anxiety levels and sleep prior to an exam in an undergraduate sample. He found that participant's sleep length was negatively correlated with test anxiety ($r = -.46, p < .001$), indicating that those with anxiety had significantly less sleep. Additionally, participants' scores on the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1983) indicated that their anxiety scores were extremely high ($M = 29.92$), reaching the 70th percentile as described by Spielberger et al.'s (2002) interpretation of the STAI. On average, college students experience greater levels of anxiety that may impact their ability to attain appropriate sleep.

Another aspect of anxiety that has been evaluated is rumination, defined as thoughts and behaviors that maintain an individual's attention on negative moods, the causes and consequences of their mood, and their evaluation of those features (Nolen-Hoeksema, & Morrow, 1991). The relationship between anxiety and rumination has been

demonstrated (Nolen-Hoeksema, 2000; Zawadzki, Graham, & Gerin, 2013) as well as relationships between rumination and poor sleep quality (Kecklund & Akerstedt, 2004), indicating that some individuals will not only experience a stressor, but will ruminate about the stressor, thereby impacting other factors including sleep.

Rumination while trying to fall asleep can result in significant impairments in the onset and duration of sleep (Lichstein & Rosenthal, 1980). Pillai, Steenburg, Ciesla, Roth, and Drake (2014) investigated the relationship between rumination and sleep difficulties. They found that ruminators had significantly longer sleep latency, even after controlling for depressive symptoms and baseline sleep difficulties. Thomsen, Mehlsen, Christensen, and Zachariae (2003) found significant relationships between rumination and participant's report of sleep disturbances. In their study, ruminators reported more difficulties initiating sleep and more fragmented sleep.

Variable sleep schedules. One of the most problematic behaviors for college students is a variable sleep schedule (Trockel et al., 2000). An individual's sleep schedule refers to the designated time for the initiation of sleep, wake time, and duration of nightly sleep. In order to meet the demands of college life, students must adapt to rapid and sporadic changes in their schedules based on class times, work, activities, and homework (Lund et al., 2010). Many students take on an irregular sleep-wake cycle, with little sleep on weekdays and later waking times on weekends, corresponding to DSPD (Brown et al., 2001; Machado, Varella, & Andrade, 1998). Approximately 57% of students work while attending college, adding additional time constraints to their already unstable schedule (Hawkins, Hawkins, Smith, & Grant, 2005).

Due to college lifestyles and the times at which courses are offered, it is difficult for students to have a standardized routine. Of those at risk for sleep difficulties, students who are not employed have the highest risk compared to those that are students who are employed (Rajaratnam et al., 2015). This may be due to relate to the stability of daily schedules for those with jobs versus students who's class times, responsibilities, and work vary or fluctuate depending on the day of the week or time of the year. Variable sleep schedules often cause difficulty with initiating sleep when desired or waking at the desired time, which can result in consistent daytime sleepiness and impairment in cognitive and emotional functioning (Belenky et al., 2003; Rajaratnam et al., 2015; Van Dongen, Maislin, Mullington, & Dinges, 2003).

DeMartini and Fucito (2014) found in their sample of 312 college students, 47% experienced feelings of sleepiness, late bedtimes, and negative consequences associated with daytime sleepiness. Their study also showed that college students as a whole report significant difficulties with daytime sleepiness, indicating they have inadequate sleep.

While some causes of sleep difficulties are apparent, many individuals are unaware of how even minor changes can affect the sleep pattern. Altering the sleep and wake times to which an individual is accustomed can have serious negative consequences. For instance, shifting the sleep schedule by as little as two hours was found to cause an increase in depressive symptoms, lower sociability, and more frequent attention and concentration difficulties (Taub & Berger, 1976; Zammit, 1988; Zammit, 1997). A study of children aged six to eleven found that a child sleeping one hour less than the recommended average was associated with a greater risk for conduct problems and behavioral issues in school (Holley, Hill, & Stevenson, 2011). The inconsistencies or

inappropriate sleep schedules that students typically follow are likely to result in frequent negative consequences.

Stimulant use. The consumption of stimulants, including caffeine, medication or other substances, and tobacco can negatively impact sleep length and quality. Ninety percent of Americans ingest caffeine on a daily basis, making it the most commonly used psychoactive substance (Hruby, 2012; Penetar et al., 1993). Increased ingestion of caffeine, including energy drink consumption, has been linked to difficulties falling asleep and more frequent sleep disturbances (Lund et al., 2010; Roehrs & Roth, 1997) and is frequently utilized in the college population to stay awake later at night or wake in the morning and increase daytime attentiveness (Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007). In fact, 42% of college students report frequent coffee consumption and 29% report regular tea drinking (Mathieson, Faris, Stam, & Egger, 1992). Furthermore, the effects of caffeine ingestion can be long lasting, up to 10 hours, depending on the person's caffeine sensitivity (Nehlig, Daval, & Debry, 1992).

Caffeine works by blocking adenosine receptors (El Yacoubi et al., 2000; Fredholm, 1995), with Adenosine typically increasing throughout the day to promote sleep at night (National Sleep Foundation, 2006a). When adenosine receptors are obstructed, it prevents depressive cellular activity and increases central nervous system activity (Solinas et al., 2002). Ingestion of caffeine and other stimulants significantly increase awareness and concentration in those who are sleep deprived until it wears off (Penetar et al., 1993). However, use of stimulants often increases anxiety and blood pressure, works as a diuretic, and can cause headaches, fatigue, and other withdrawal symptoms if discontinued (Green, Kirby, & Suls, 1996; Julianao & Griffiths, 2004). In

addition to the physiological consequences, increased stimulant use has been linked to greater perceived sleep difficulties such as insomnia, which can also lead to sleep problems (Hindmarch et al., 2000).

When evaluating energy drink consumption in college students, Malinauskas and colleagues (2007) found that 51% of their sample was energy drink users. Out of the identified consumers of energy drinks, 67% cited insufficient sleep as their reason for use and 50% reported consumption of energy drinks while studying or completing major course assignments. This study indicates that many college students are consuming caffeine to alleviate consequences of sleep deprivation.

Some students may also take prescription or over the counter stimulants to stay awake. Lund et al. (2010) found that students that reported poor sleep quality were more than twice as likely to consume stimulants in order to stay awake. Low and Gendaszek (2002) found that 35% of college students use prescription amphetamines such as Adderall without a prescription within the past year to stay alert or awake. The strength of amphetamines in prescription medications promotes alertness extremely well depending on the dosage (Penetar et al., 1993).

Nicotine in tobacco is also a stimulant that is negatively associated with sleep. Tobacco use is typically initiated in adolescence (Brown, Lewinsohn, Seeley, & Wagner, 1996) and serves as the initial use of a substance before use of alcohol, cannabis, or other substances (Bailey, 1992; Henningfield, Clayton, & Pollin, 1990; Kandel & Yamaguchi, 1993). Approximately 26% of college students have used tobacco products within the last 30 days (Latimer, Batanova, & Loukas, 2014), with 28% of smokers identifying that they

began smoking once they reached college (Wechsler, Rogotti, Gledhill-Hoyt & Lee, 1998).

Interestingly, light smoking (less than 15 cigarettes per day) is associated with insomnia whereas heavy smoking (more than 15 cigarettes per day) did not affect sleep (Riedel, Durrence, Lichstein, Tylor, & Bush, 2004). This may be due to a tolerance of nicotine in experienced and heavy smokers. Both regular and experimental use of tobacco significantly contributes to sleep difficulties after controlling for age, race, gender, and family income (Patton et al., 1998). In addition to routine sleep disturbances, the counter productivity of nicotine to quality sleep is further demonstrated by increased rates of nightmares among heavy smokers (National Sleep Foundation, 2006b).

Alcohol and substance use. College is a time of increased marijuana, tobacco and alcohol use (Brown et al., 2001; Rhoades & Maggs, 2006; Sierra, Jimenez-Navarro, & Marin-Ortiz, 2002; Vail-Smith, Felts, & Becker, 2009). Results consistently indicate a relationship between the consumption of alcohol and decreased sleep length and quality (Galambos et al., 2009; Singleton & Wolfson, 2009). Many students believe that alcohol is a sedative that will help them to sleep, but the opposite is actually true and it causes individuals to wake throughout the night and prevents individuals from attaining deep or REM sleep (National Sleep Foundation, 2006a). In addition, adolescent and young adults are more likely to experiment or engage in use of illegal substances. Incidents of substance use may be the result of self-medicating to treat insomnia and other sleep difficulties (Roehrs & Roth, 2001).

Participants in DeMartini and Fucito's (2014) study evaluating sleep patterns in at risk college student drinkers were divided into four groups based on their sleep patterns

and subsequent consequences: Sleepiness (11% of the sample), sleepiness and late bedtimes (42% of the sample), sleepiness and late bedtimes with consequences (28% of the sample). The final group included sleepiness, late bedtimes, and sleep disturbance with consequences (19% of the sample). Each successive group included features of the previous group with additional variables or risks associated with sleep difficulties. The third group, sleepiness and late bedtimes with consequences, included additional identifiers of sleeping past noon and the necessity of multiple alarms or reminders to get out of bed in the morning. The fourth group, sleepiness, late bedtimes, and sleep disturbances with consequences, reported symptoms of difficulty falling asleep and difficulty staying awake, with greater risk of falling asleep in class, oversleeping, or tardiness in addition to the characteristics included in group three. Results indicate that the majority of college students have difficulties with inappropriate bed times and daytime sleepiness. The results also showed that those with sleep disturbances and higher rates of sleep impairment have the highest rates of alcohol consumption, alcohol related difficulties, and illicit substance use.

Students that live away from home have higher rates of alcohol consumption (Kuo et al., 2002) and binge drinking, which is defined as five or more drinks on one occasion for a male and four or more drinks on one occasion for a female (Substance Abuse and Mental Health Services Administration [SAMHSA], 2006). Binge drinking peaks between the ages of 18 to 22, with 40% of college students having engaged in binge drinking (Wechsler, Davenport, Dowdall, Moekens, & Castillo, 1994).

Binge drinking is positively associated with falling asleep in class (Jean-Louis, Zizi, von Gizycki, & Nunes, 1998) due to disturbances in REM sleep (Buboltz et al.,

2006; Roehrs & Roth, 2001). Although increased alcohol consumption can initially have a sedating effect, it quickly dissipates and is shadowed by significant disruptions in sleep, especially during the later part of the night associated with longer durations of deep sleep (Landolt, Roth, Dijk, & Borbely, 1996; Roehrs & Roth, 2001; Stein & Friedmann, 2005; Van Reen, Tarokh, Rupp, Seifer, & Carskadon, 2011). The beginning stages of the sleep cycle allow for alterations in order to normalize sleep patterns; however, once the effects of alcohol have worn off, an individual's sleep patterns will attempt to normalize by reversing their earlier alterations, resulting in arousal and disturbances in sleep (Roehrs & Roth, 2001). Pavlovć and Dindić (2014) found that first year doctoral students that consumed alcohol experienced decreased sleep quality, but not length, compared to first year doctoral students that did not drink alcohol. In their study, those that consumed alcohol did so an average of once per week, signifying that even infrequent alcohol use can negatively impact sleep.

Sleep and alcohol consumption show a significant reciprocal relationship with one another. Students that report higher frequency consumption of alcohol frequently report increased amounts of sleep on weekends, greater discrepancy between their bedtimes during the weekend and weekdays, and decreased sleep duration compared to their peers that report fewer drinking behaviors (Singleton & Wolfson, 2009). Orzech, Salafsky, and Hamilton (2011) found that sleep patterns and sleep-related problems such as decreased sleep quality, shorter duration of sleep, and increased discrepancies in sleep patterns were associated with increased alcohol use. Compared with students with fewer sleep difficulties, students that have problems sleeping will increase their alcohol consumption to induce sleep (Lund et al., 2010). Sleep deprivation and alcohol ingestion can also

increase the risk of negative behavioral actions such as fighting or problems with school due to hangover or state of intoxication (Kenney, Labrie, Hummer, & Pham, 2012). The importance of sleep and alcohol consumption can be further demonstrated by the fact they are both significant risk factors for unintentional accidents, including motor vehicle accidents, which are the leading cause of death for individuals between 18 and 22 years old (Brooks, Girgenti, & Mills, 2009; Center for Disease Control (CDC), 2008; Hingson, Zha, & Weitzman, 2009).

Cannabis use affects various areas of the brain that aid in the regulation of sleep. Cannabis intoxication impairs attention, cognition, and arousal (Adams & Martin, 1996; Martin, Ledent, Parmentier, Maldonado, & Valverde, 2002; D'Souza et al., 2004). Muntoni et al. (2006) investigated the effects of cannabinoids on various areas of the brain and subsequent functioning in both humans and animals. Their results indicate that cannabis impacts the noradrenergic pathway from the locus coeruleus that may account for decrements of anxiety, arousal, and emotional states that can negatively impact sleep.

Methylendioxyamphetamine (MDMA), or ecstasy, is a substance consumed in conjunction with dance parties to increase feelings of euphoria and to stay awake for extended periods of time. It depletes neuronal serotonin, which plays a role in the regulation of physiological and behavioral systems including the sleep-wake cycle and circadian rhythms (Monti, Pandi-Perumal, Jacobs, & Nutt, 2008). Individuals that use ecstasy have significant reports of symptoms consistent with insomnia and sleep related disturbances, even after controlling for polysubstance use (Ogeil, Rajaratnam, Phillips, Redman, & Broadbear, 2011).

Substance use has a significant relationship with sleep and sleep related difficulties, even after accounting for other variables. Johnson and Breslau (2001) found that substance use was strongly associated with sleep, even after adjustments for both internalizing and externalizing behaviors. Longitudinal studies have demonstrated significant relationships between sleep and onset of alcohol, marijuana, tobacco, and illicit drug use (Wong, Brower, Fitzgerald, & Zucker, 2004; Wong, Brower, Nigg, & Zucker, 2010; Wong, Brower, & Zucker, 2009). Adolescents that report increased feelings of lethargy also have increased rates of substance use (Tynjala, Kannas, & Levalahti, 1997).

Circadian preference. Individuals have circadian preferences that relate to their partiality toward being more morning or night oriented, such as being considered a night owl or a morning lark. A circadian preference is sometimes referred to as a person's morningness-eveningness (Natale & Cicogna, 2002). Those with an evening preference tend to go to bed later and rise later in the morning, whereas those with a morning preference tend to go to bed earlier and wake earlier. Circadian preference is on a continuum and is influenced by circadian rhythm, development, exposure to light, and lifestyle choices and obligations (Beersma & Gordijn, 2007; Carrier, Monk, Buysse, & Kupfer, 1997; Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998; Monk, Reynolds, Buysse, DeGrazia, & Kupfer, 2003; Taillard, Philip, & Bioulac, 1999).

During adolescence, individuals go through biological changes that will impact their circadian rhythms in addition to the changing environment and pressures relating to college life (Orzech et al., 2011). In adolescence, a preference for evening types is more frequent (Carskadon et al, 1998). This preference tends to decline during the adult years,

with morning preference type increasing in adulthood (Carrier et al., 1997). This implies that college students are more likely to have an evening preference type or intermediate preference type that fluctuates between morning and evening type. The evening preference type may have implications for college students due to early morning requirements.

Evening types with later bed times coupled with difficulty adjusting their sleep schedules to incorporate morning wake times often results in insufficient sleep, poor and irregular sleep habits, and daytime sleepiness (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002). Those with an evening type preference sleep tend to sleep less during the weekdays and sleep longer on weekends, which may lead to DSPD (Giannotti et al., 2002; Taillard et al., 1999). Compared to morning types, evening types report decreased sleep quality (Gaina et al., 2006; Giannotti et al., 2002; Megdal & Schernhammer, 2007) as well as subjective perceptions of a need for increased sleep (Taillard et al., 1999).

Technology use. Technology disrupts sleep in young adults (Crowley, Acebo, & Carskadon, 2007). The use of computers, television, and cellular phones are now commonplace and can affect an individual's sleep habits (Van den Bulck, 2004). Social media outlets such as Facebook, Instagram, and Twitter are used for substantial amounts of time every day and are commonly accessed before going to sleep for the night. While some researchers suggest that rapid increases in technology use has ceased (Smith, Salaway, & Borreson Caruso, 2009), the use of cellular phones and technology is undermining sleep quality and quantity (Cain & Gradisar, 2010).

The National Sleep Foundation (National Sleep Foundation, 2011) found that 50% of teenagers used their cellular phones and the Internet within an hour of going to

sleep for the night and that 20% were woken up by their cellular phones after they had fallen asleep. These numbers are even higher in college students with 25 to 47% experiencing sleep disruptions due to their cellular phone use (Adams & Kisler, 2013; Thomee, Harenstam, & Hagberg, 2011). A recent study indicated that 47% of students reported waking during the night and responding to text messages and 40% woke to answer phone calls after falling asleep at night (Adams & Kisler, 2013). Repeatedly being woken after sleep onset results in fragmented sleep and poor sleep quality that does not allow the individual to wake feeling refreshed and well rested. Technology use is a pervasive distraction in the life of a college student and responding to calls or text messages during the night often causes users to have disrupted and fragmented sleep patterns that are related to decreased GPA, attentional and concentration difficulties, depression and anxiety (Adams & Kisler, 2013; Trockel et al., 2000).

Adolescents and young adults are impulsive and with the expansion of cellular phones and their portability, many use their cellular phones regularly and do not adhere to appropriate boundaries of use (Adams & Kisler, 2013). Individuals with four or more technological devices obtain significantly less sleep (National Sleep Foundation, 2006b) and the excessive use of computers, cellular phones, and the Internet in bedrooms delay an individual's bedtimes as well as the rise time in the morning (Brunborg et al., 2011; Suganuma et al., 2007). Individuals that wake throughout the night to utilize technology such as texting or answering phone calls have significantly decreased sleep quality, which has been linked to mental health symptoms associated with depression and anxiety (Adams & Kisler, 2013).

White, Buboltz, and Igou (2011) evaluated the relationship between mobile phone use and sleep length and sleep quality in college students. Participants in the study attained an average of seven and a half hours of sleep per night, reported moderate sleep quality with occasional sleep difficulties, and spent an average of five hours per day on their mobile phones. The results of this study indicated that addictive text messaging ($r = .15, p = .01$), pathological texting ($r = .18, p = .00$), and problem mobile phone use ($r = .17, p = .00$) were significantly related to sleep quality, but were not significantly related to sleep length. Additionally, regression analysis identified that pathological texting, which includes characteristics of withdrawal, mood, and interpersonal conflict, is a significant predictor of sleep quality. This study illustrates the impact that technology, specifically mobile phone use, has on an individual's ability to attain adequate sleep quality, allowing them to wake feeling rested and refreshed. It may be that students wake throughout the night to respond or check on their mobile phones and then return to sleep so that there are getting the recommended amount of sleep, but it is fragmented and does not allow for the normal cycle through the sleep stages.

There are also biological components of technology use that interfere with sleep. The bright lights of technological devices delays the onset of sleep by increasing physiological arousal and suppressing the production of melatonin (National Sleep Foundation, 2011; Harvey, 2000). The light emitted by technology devices when going to sleep for the night can alter brain functioning and create a state of increased awareness and consciousness, resulting in extended amounts of time to fall asleep.

Consequences of Sleep Difficulties

Sleep is vital to physical and mental health, with inadequate sleep negatively impacting various aspects of an individual's life (Roane & Taylor, 2008). College students with sleep difficulties have increased risk for physical health problem (Gailliot et al., 2007; Irwin et al., 1996) as well as higher prevalence rates of DSPD (American Academy of Sleep Medicine, 2005; Roenneber et al., 2004), mental health concerns (Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010; Lund et al., 2010), cognitive impairment (Barnes & Hollenbeck, 2009; Pilcher & Walters, 1997), and academic performance (Gilbert & Weaver, 2010; Trockel et al., 2000). When adolescents and young adults have sleep difficulties, the impact on their daytime functioning can be detrimental (Curcio, Ferrara, & De Gennaro, 2006; Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010; Fallone, Owens, & Deane, 2002; Mitru, Millrood, & Mateika, 2002; Moore et al., 2009; Wolfson & Carskadon, 2003).

Physical health. According to the National Sleep Foundation (2006a), sleep is not only necessary, it may allow the body to heal itself, as evidenced by increased production of proteins responsible for cell growth and repair of damage that occurs when sleeping. When adequate sleep is not achieved, it can negatively impact the endocrine and immune system, increasing the risk of many health factors and conditions. More recently, researchers have linked sleep loss to many serious health conditions including obesity, diabetes, and hypertension. Relatively small changes in a person's lifestyle, including getting more sleep, can cause substantial decreases in health risks (Meyer & Boll, 2014). Consistent difficulties with sleep are also related to irritability, migraine, headache, and muscle pain (Marano, 2003).

Sleep plays a role in the maintenance and efficacy of our immune system (Irwin et al., 1996; Spiegel et al., 2002). When people get sick, they often stay in bed and get increased amounts of sleep to assist them in getting better. The opposite is also true, meaning that those that do not get enough sleep are more likely to have a decreased immune system, which leads to increased rates of illness, take longer to recover, or have serious medical illness. In 2002, Spiegel, Sheridan, and Van Cauter evaluated the efficacy of a flu vaccine in participants that had only been allowed to sleep for four hours per night for four nights in a row and a group that was allowed to sleep normally. Ten days following the administration of the flu vaccine, participants in the sleep deprivation group showed markedly lower immune response when compared to those that slept normally. Further analysis showed that the sleep deprived group produced less than half of the antibodies to fight illness than the individuals with adequate sleep.

The Center for Disease Control and Prevention (2013) reports that approximately 65% of American's are overweight or obese. While this is typically attributed to sedentary lifestyles and high caloric intake, researchers have begun investigating the role of decreased sleep in this epidemic. A recent study of Finnish adults revealed that participants sleeping five or fewer hours per night had substantially greater weight gain (Lyytikainen et al., 2011). Another study found that young men that do not get adequate slow wave sleep had decreased production of human growth hormone, which controls the body proportion of fat and muscle (Van Cauter et al., 2000). This means that men with less human growth hormone are more likely to be overweight. Taheri, Lin, Austin, Young, and Mignot (2004) evaluated the relationship between sleep and leptin, and ghrelin, which are key hormones involved in appetite regulation and BMI. Leptin is a

hormone responsible for suppressing appetite (Zigman & Elmquist, 2003), whereas ghrelin is a stomach peptide that stimulates appetite (Cummings & Foster, 2003; van der Lely, Tschop, Heiman, & Ghigo, 2004). Results showed that individuals with shorter sleep duration had significantly decreased amounts of leptin and significantly increased amounts of ghrelin, which may help explain the relationship between sleep and obesity.

Sleep deprivation impacts the body's ability to process blood glucose, which is utilized by the human brain to promote healthy functioning. This can result in increased production of insulin and promotion of pre-diabetic states (Speigel, Leproult, & Van Cauter, 1999). The decreased rate of glucose metabolic activity in the prefrontal cortex resulting from sleep deprivation will also result in impairment in executive functioning, impulsivity, and decision making that can result in serious injury (Dahl & Lewin, 2002; Gailliot et al., 2007).

Both short-term and long-term sleep loss has been correlated with increased blood pressure, which lasts not only that night but also throughout the following day, as well as greater risk of stroke (Rosansky, Menachery, Whittman, & Rosenberg, 1996) and cardiovascular concerns (Bonnet & Arand, 1998). Sleep deficits have also been linked to increased cardiovascular problems. A study by Bonnet and Arand (1998) found a relationship between chronic sleep deprivation and coronary heart disease. The link between sleep and cardiovascular disease has been demonstrated in women (Ayas et al., 2003), a mixed sample of adults (Apples & Mulder, 1984) and adults over the age of 65 who also showed decreased health in other areas (Asplund, 2000; Newman, Enright, Manolio, & Haponik, 1997).

Obstructive Sleep Apnea (OSA) is a medical condition in which individuals experience disjointed sleep patterns due to pauses in breathing while trying to sleep, resulting in multiple significant short and long-term health outcomes including impaired functioning throughout the day, hypertension, diabetes, heart attack and stroke (Redline et al., 2010). This condition is being seen more frequently in younger populations and may be under-diagnosed in college-aged students (Gaultney, 2010). Children as young as five years old have been found to have significantly greater reports of bodily pain when they suffer with disordered breathing while sleeping (Rosen, Palermo, Larkin, & Redline, 2002).

Mental health. In addition to the physical consequences associated with sleep deprivation, there are also many adverse psychological outcomes related to inadequate sleep. There is a significant relationship between sleep and mood (Gregory & Sadeh, 2012) and individuals that have substandard sleep quality have significantly higher incidence of unfavorable emotional outcomes (Baglioni et al., 2010; Deliens, Gilson, & Peigneux, 2014). Decreased sleep is linked to increased rates of depression, anxiety, anger, fatigue, and confusion in undergraduate students (Buboltz et al., 2006; Krennek, 2006; Pilcher & Ott, 1998). Elevations of negative mood and stress levels predispose individuals to not only an increased risk of depression, but also suicidal ideation and physical aggression (Lund et al., 2010; Nadorff, Nazem, & Fiske, 2011; Vail-Smith et al., 2009). In addition to problems with emotion regulation, individuals that do not get the recommended amount of sleep commonly report lower life satisfaction (Taylor, Bramoweth, et al., 2013), are more likely to dismiss social conventions (Ghumman &

Barnes, 2013; Horne, 1993), and have increased rates of unethical behaviors (Barnes, Schaubroeck, Huth, & Ghumman, 2011; Christian & Ellis, 2011).

Sleep has relationships with many mental health disorders and negative behaviors. Vollrath, Wicki, and Angst (1989) explored co-morbidity of insomnia and other mental health disorders in young adults. This early study showed that in individuals with insomnia had higher rates of major depression, generalized anxiety, phobias, and panic episodes. More recent research found that when compared to individuals without sleep difficulties, those with insomnia had greater incidence of somatic complaints, obsessive-compulsive features, depression, anxiety, and distress (Taylor et al., 2011). The relationship between sleep and psychological health can be inferred from the number of mental health disorders that include sleep disruption as a component of the diagnostic criteria. According to the Diagnostic and Statistical Manual of Mental Disorders- Fifth Edition (DSM-5; American Psychiatric Association, 2013), sleep disruption is a criterion for the diagnosis of major depressive disorder, post-traumatic stress disorder, bipolar disorder, schizophrenia, and numerous others (American Psychiatric Association, 2013).

Multiple studies have shown a relationship between sleep and depressive symptoms (Gregory & Sadeh, 2012; Mitru et al., 2002; Moore et al., 2009). Some researchers have even suggested that sleep difficulties are a predictive factor in the development of depression (Fava, Grandi, Canestrari, & Molnar, 1990; Manber & Chambers, 2009; Perlis, Giles, Buysse, Tu, & Kupfer, 1997). In fact, chronic reduction and fragmentation of sleep may be the most predictive factor for the onset of depression (Mellman, 2006). A meta-analysis by Baglioni et al. (2011) found that people suffering from insomnia are twice as likely to develop depression compared to those without sleep

disturbances. College students struggling with depression and sleep difficulties, also have increased rates of co-morbid anxiety and report excessive attentiveness to anxiety provoking stimuli (Nyer et al., 2013).

Researchers at the University of Pennsylvania studied the outcome of reduced sleep over a period of time (Dement & Vaughan, 1999). Participants in the study were permitted to sleep 4.5 hours per night for seven days. Their mood and energy showed steady decline over the seven-day period. They also described significantly greater feelings of anger, sadness, stress, and overall mental fatigue. After the test period, participants were permitted to get adequate sleep, resulting in dramatically increased scores on mood measures.

Stress levels are also significantly increased in many students because they commonly feel overwhelmed by the changes and increased demands of college courses or workload (Lund et al., 2010). Sleep quality is negatively correlated with interpersonal and school stressors in undergraduate students (Fortunato & Harsh, 2006). Fuligni and Harway (2006) found that increased studying and stress negatively impacted students sleep length in ninth grade and that their decreased sleep was associated with higher anxiety, depressed mood, and fatigue.

Humans that have significant sleep disturbances are often plagued by emotional reactivity and struggle with emotion regulation (Baglioni et al., 2010). This means that they may have disproportionate responses and react more impulsively and negatively than is normal. Individuals with sleep difficulties may also display labile mood characteristics and affect (Kahn-Greene, Killgore, Kamimori, Balkin, & Killgore, 2007). It is theorized that the lack of emotional stability and emotional reactivity that occurs as a

result of insufficient sleep may be related to difficulties with cognitive processes that affect accuracy of an individual's perceptions (Baglioni et al., 2010; Mauss, Troy, & LeBourgeois, 2013).

There have also been examples of individuals that were deprived of sleep over long periods, resulting in drastic negative consequences. For example, in 1959 a DJ decided to raise money for a charity by staying awake for 200 hours. In order to achieve this, he was placed in a glass booth in New York making radio broadcasts and having other ensure he did not fall asleep. After a few days without sleep, he was described as disoriented with slurred speech and displayed signs of paranoia and hallucinations. Toward the end of his 200-hour event, he was irrational and uncooperative, stating his food was poisoned. An EEG after 201 hours of sleep deprivation showed brain wave patterns characteristic of a person sleeping even though he was still awake (Dement, 1976).

Cognitive functioning. One of the major consequences of decreased sleep is daytime sleepiness and decreased cognitive performance (Wyatt & Bootzin, 1994). Sleep deprivation commonly causes confusion and fatigue (Taylor, Vathauer, et al., 2013), which can result in significant impairments in cognitive functioning including memory and attention impairment (Pilcher & Walters, 1997; Taylor & McFatter, 2003; Yang et al., 2008). Engle-Friedman et al. (2003) found that when sleep loss occurs, the result is a preference for minimally demanding cognitive tasks in order to maintain performance.

A study by Kuo (2001) investigated differences in performance and attention abilities between individuals that were deprived of sleep and those that were considered legally intoxicated. The results showed that participants that were awake for up to 19

hours performed significantly worse on assessments of performance and alertness than those that were legally intoxicated. Considering the risks and outcomes associated with increased alcohol use, this demonstrates the breadth of impairment that can accompany sleep difficulties. Harrison, Horne, and Rothwell (2000) explored the effects of inadequate sleep on cognitive performance by comparing a group of sleep deprived young adults and those with normal sleep. Results show that participants that were deprived of sleep for 36 hours had significantly worse cognitive performance on tasks than those with sufficient sleep.

Concentration and memory are necessary abilities for individuals to succeed in their college career. Impairments in procedural and declarative learning, memory consolidation, problem solving, and critical thinking have been found in individuals who are deprived of sleep or do not obtain the recommended sleep allotment (Curcio et al., 2006). Individuals that get too little sleep (less than 5 hours of sleep) or too much sleep (more than 10 hours) exhibit impairments in working memory (Wilckens, Woo, Kirk, Erickson, & Wheeler, 2014), which is responsible for the ability to process several ideas simultaneously and is vital to the encoding of information and learning (Baddeley, 2000). Researchers have found relationships between attention, sleep, and working memory. Individuals that are sleep deprived for up to 21 hours display decreased accuracy and response times compared to their baseline evaluations (Smith, McEvoy, & Gevins, 2002).

Lim and Dinges (2008) conducted a meta-analysis of 176 articles evaluating the effects of total sleep deprivation and cognitive performance. They found a significant effect between lack of sleep and working memory performance, with deficits more pronounced in accuracy and reaction time following sleep deprivation. Lim and Dinges

(2010) conducted another meta-analysis of 70 articles with a total of 147 data sets to again explore the relationship between sleep deprivation and cognitive performance. This analysis utilized results from studies of cognitive performance that included attention (visual, auditory, and selective), memory (working and short term), processing speed, and/or reasoning. Individuals have significantly different performance across all cognitive areas when sleep is neglected, with the greatest detriment in tasks requiring attention, followed by processing speed, working memory, and short-term memory.

Inadequate sleep can cause a significant negative impact on attention, as evidenced by Chua and associates' (2014) study. Participants remained awake for 26 consecutive hours during which time they would complete a task assessing their reaction time every two hours. Results indicated that when participants were prevented from sleeping, their ability to maintain attention and performance on the psychomotor vigilance task was more variable and reaction time slowed. Even with a single night of sleep deprivation, individuals may report increased agitation and reactivity, decreased reaction time, and negative mood compared to those that attained appropriate sleep (Frazen, Siegle, & Buysse, 2008).

Pilcher and Walters (1997) conducted multiple research studies to examine the relationships between health, well-being, drowsiness, sleep quality, and sleep length in college students. The data for the first study was collected during a more stressful time of the semester than the data collected during the second study. After analyzing the data, results indicated that students with poorer sleep quality had more frequent health issues, confusion, mood difficulties, including depression, anxiety, and irritability, and lower levels of life satisfaction. These symptoms and decreased sleep quality were not

significantly different when comparing data during the less stressful time and more stressful time of the semester.

Another study by Pilcher and Walters (1997) explored the relationship between sleep and cognitive performance. Participants were divided into a group that slept for eight hours or a group that was deprived of sleep for a 24-hour period, which included inability to attain REM sleep that is needed for memory consolidation and learning. Both groups completed assessments evaluating their mood, critical thinking, and irrelevant thoughts. Although participants in the sleep deprived group reported no significant difficulties with concentration or performance, their objective assessment indicated they struggled with critical thinking, concentration, and ability to focus. This study showed that not only is cognitive performance impaired after lack of sleep, but also students may have a perception that they are performing normally and are not being impacted by poor sleep.

Kyle, Espie, and Morgan (2010) evaluated areas of concern in individuals with insomnia through focus groups. Participants reported consistently feeling like they were “struggling” throughout the day to complete tasks, specifically those requiring attention, concentration, and memory. Specific examples provided by their participants included a need to read items repeatedly in order to understand and retain information, feeling distracted and higher rates of accidents, and making careless mistakes on tasks that should not be difficult such as filling out their name or birthdate. Their study also found that after several days of poor sleep, participants reported drastic changes in their mood and not feeling like themselves. Examples given included short tempers, easily irritated, and excessive worry about other’s evaluations and observations of decreased

performance and mood. Some participants also reported outburst of tears for no apparent reason and feelings of loneliness. Vocational functioning was also influenced in Kyle and colleagues' study (2010) as evidenced by self-reports of inadequate performance and absence from work or school in some instances. Participants that were involved with education specifically reported struggling with learning and retention of information, leading them to decreased feelings of self-worth. As a consequence of the problems in functioning across areas, participants frequently avoided social activities or declined to attend normal outings due to increased fatigue, awareness of mood difficulties, or concerns about being judged by others. Overall, self-reports highlighted deficits in emotional, cognitive, and physical functioning as a result of sleep deprivation.

Individuals deprived of sleep for a single night will be in a state of diminished cognitive capacity (Barnes & Hollenbeck, 2009). This suggests that sleep loss could constrain performance in academics, extracurricular activities, and possibly even career aspirations for some students. Attention problems are frequently associated with sleep difficulties (Gregory & Sadeh, 2012; Mitru et al., 2002; Moore et al., 2009).

Neuropsychological assessments evaluating executive functioning, which includes planning, judgment, decision-making, and cognitions, finds evidence of problematic functioning following sleep loss (Harrison & Horne, 2000; Jones & Harrison, 2001; Muzur, Pace-Schott, & Hobson, 2002).

As previously stated, individuals that do not get adequate sleep will not obtain enough REM sleep since the amount of time spent in REM sleep increases throughout the night and has its longest cycle between six to seven and half hours after sleep onset (Carskadon & Dement, 2011). This illustrates the important role that the final hours of

sleep play in acquiring appropriate amounts of time in REM sleep, which is necessary for learning and memory consolidation (De Koninck, Lorrain, Christ, Proulx, & Coulombe, 1989). Due to variable sleep schedules and decreased sleep length in college students, many do not complete the normative sleep cycles and are not asleep long enough to attain the final hours of REM sleep responsible for consolidation of memories and learning (Smith & Lapp, 1991)

Academic performance. The link between sleep length quality and academic performance is well documented (Gilbert & Weaver, 2010; Kelly et al., 2001). The relationship between sleep difficulties and academic performance has been found in elementary students (El-Sheikh, Buckhalt, Keller, Cummings, & Acebo, 2007), junior high and high school students (Chung & Cheung, 2008, Joo et al., 2005; Lazaratou, Dikeos, Anagnostopoulos, Sbokou, & Soldatos, 2005), and college students (Lack, 1986). Those who sleep less have decreased academic performance (Kelly et al., 2001) and those that wake up later also have impaired academic performance (Trockel et al., 2000). Academic performance is impacted by sleep onset, sleep length, and sleep irregularities (Medeiros, Mendes, Lima, & Araujo, 2001). Many students are unaware that academic difficulties may be related to their poor sleep habits (Pilcher & Walters, 1997).

Lack (1986) explored factors relating to sleep and academic performance in a sample of Australian college students. Nearly 20% of participants reported difficulties falling asleep and more than 10% reported waking before intended in the morning and having general sleep difficulties. Upon further evaluation of the sample, 17% met criteria for DSPD and also had lower GPA, daytime fatigue, and emotional reactivity compared to those that did not meet criteria for DSPD.

Gilbert and Weaver (2010) performed a large-scale study to look at the relationships among sleep deprivation, sleep quality, and academic performance in college undergraduates. Their analysis indicated a significant relationship between the global sleep quality subsection of the Pittsburgh Sleep Quality Index and student grade point average (GPA). Students reporting lower sleep quality had significantly lower academic performance, as evidenced by a lower GPA. The relationship between sleep and academic performance was more pronounced in females than males with researchers suggesting sleep quality and academic performance may be more closely related in females for an unknown reason.

Studies repeatedly demonstrate a positive relationship between student's GPA and sleep quality, specifically those students with poorer sleep quality were found to have lower GPAs (Howell, Jahrig, & Powell, 2004; Lust, Ehlinger, & Golden, 2011). Kelly, Kelly, and Clanton (2001) explored the relationship between sleep length and GPA. Participants included 147 college students that were divided into groups based on the length of sleep each acquired per night. Those with six hours of sleep or less were labeled short sleepers, those with seven to eight hours of sleep were labeled average sleepers, and those with nine or more hours of sleep were labeled long sleepers. Students in the short sleepers group (2.7) had a lower GPA than long sleepers (3.2), with average sleepers falling in the middle of the distribution. Orzech, Salafsky, and Hamilton (2011) found a modest relationship between sleep quality and GPA and that those that did not engage in occasional deprivation of sleep for a night had a higher overall GPA compared to students that did occasionally stay up all night.

Trockel, Barnes, and Egget (2000) evaluated the relationship between several health variables and academic performance. Their results indicated that student wake time was the most powerful indicator for variations in grade point average (GPA), which is consistent with symptoms of DSPD. Variations in sleep patterns affect school so drastically that student GPA dropped an average of .13 points for each hour their wake time was delayed on a weekday and that their GPA decreased an average of .11 points for each hour wake time was delayed on weekends. Lund and colleagues (2010) researched the impact of health variables in college students. They collected data from 24,018 students at 14 different colleges. The results indicated that out of the variables assessed, sleep difficulties were one of the only ones to affect a substantial amount of their population (50.3%) and continually impacted student GPA. They also noted that student GPA increased as they attained adequate amounts of sleep.

Gaultney (2010) evaluated the prevalence of sleep disorders in college students as well as its impact on academic performance. He found that students with one or more sleep problems have a significantly lower GPA than those without a self-reported sleep disorder. When students reported sleeping poorly on a regular basis, they were more likely to have a lower GPA than those reporting occasional or rare sleep disturbances. Student GPA was also related to sleep duration prior to school, showing that those that had increased sleep prior to school and more consistent sleep schedules had higher grades. In addition, of those students on academic probation for poor academic performance, 22% reported difficulties with insomnia and 26% reported struggling with circadian rhythm disorders, further evidence for the link between sleep and academics. The participants evaluated primarily identified themselves as evening types, reporting

less sleep during the week and more sleep on weekend, which is consistent with diagnosis of DSPD. In fact, students had an average of two and a half hours difference between the amounts of sleep during the week versus amount of sleep on weekends. Gaultney concluded that the best solution for improving sleep in college students is to treat sleep disorders and improve sleep practices, which will likely result in increased student GPA, higher rates of enrollment, and greater numbers of students graduating from college.

A study to evaluate the relationship between sleep, academic performance and substance use in adolescents was conducted by Wong, Rowland, and Dyson (2014). Their study included 171 adolescents from two schools. Wong and associates discovered individuals that are unable to obtain appropriate levels of sleep have decreased perceptions regarding controlling their efforts and are less likely to feel that academic endeavors are important. This internalized idea about personal values can significantly impact academic performance. Sleep impacts so many areas necessary for learning and achievement that those that do not get enough sleep feel they are unable to control their attention, concentration, or behaviors. A relationship between sleep and initiation of undesirable activities, such as homework or studying, was also found with sleep disruptions resulting in perceived inability to perform tasks. In addition, they found that when students are sleep deprived, they struggle with regulation and are more likely to be disruptive in a classroom setting. This disruptive behavior can impact the student-teacher relationship and the ability to learn by creating tension and student disengagement from the academic environment.

Taylor, Vathauer, et al. (2013) comprehensively evaluated the relationships among academic performance and sleep factors, as well as other psychological and academic variables. Results corroborate other researchers by indicating that sleep measures accounted for a significant amount of variance in academic performance. Specifically, students with later sleep and wake times, longer nap periods, and those that spent more time lying in bed after waking in the morning had significantly lower GPA. Declines in academic performance were also seen in relation to inconsistent sleep schedules, longer sleep onset, and sleep efficacy. In the overall model of their study, the only modifiable risk factor for academic performance with imputation was variables related to sleep, signifying its importance. After imputation, sleep variables maintained their significance and variables for alcohol and stress were also significant.

Sleep Interventions

There are a variety of techniques and treatment options for those with sleep problems including both pharmacological and psychological. Pharmacological treatments for sleep problems are effective, but in some instances the effects are not long lasting. In most cases, they do not resolve the underlying problem causing the sleep disturbances (Ohayon et al., 1999). In addition, they may have negative side effects. Psychological interventions for sleep difficulties have shown significant improvement for individuals (Lichstein & Riedel, 1994; Morin et al., 1994; Morin & Wooten, 1996; Murtagh & Greenwood, 1995) and may include psychoeducation, behavioral interventions, and cognitive interventions. Behavioral treatments work similarly to pharmacological therapy options in that they decrease arousal. One potential concern in the use of psychological treatments, including psychoeducation, is that individuals must have a

certain level of cognitive abilities so that they can understand, learn and apply the information or techniques they are taught.

Pharmacological interventions. There are non-prescription options that are marketed as sleep aides. While these can be effective in assisting with the onset or duration of sleep, many have unwanted side effects and will not provide long lasting or effective relief from sleep difficulties (National Sleep Foundation, 2006a). Many of the over the counter sleep aides contain antihistamines that promote sleep, but can also cause symptoms of blurry vision, dry mouth, and excessive drowsiness during the day. Melatonin is another example of a frequently used sleep aid that does not require a prescription. While this supplement is linked to sleep and can assist in achieving greater sleep, clinical studies regarding the safety of taking melatonin have not achieved consistent results and is therefore discouraged unless approved by a physician.

Prescription medications have been used for many years to assist individuals with sleep difficulties. Since the introduction of benzodiazepines in 1964, this category of medicine has been used as a sleep aid. These substances work through depression of the central nervous system as well as having an inhibitory effect on the neurotransmitter gamma-aminobutyric acid (GABA), which is believed to foster sleep, cognitive, memory and psychomotor functions (National Sleep Foundation, 2006a). Negative side effects for benzodiazepines include memory loss, rebound insomnia, and the potential for dependence (Wagner & Wagner, 2000).

In the early 1990's nonbenzodiazepines or nonbenzodiazepine receptor agonists were introduced as sleep aides. These work specifically on subtypes of GABA receptors with shorter acting compounds, thereby decreasing the risk of daytime drowsiness and

memory impairment. However, this group of medications still has negative side effects including the potential for rebound insomnia, drowsiness, feelings of dizziness, and problems with coordination (Wagner & Wagner, 2000).

Medication use for sleep difficulties can increase sleep length and sleep quality, but can also have a negative impact on health and functioning. Many pharmacological treatments are effective at ameliorating sleep difficulties (Ohanyon et al., 1999), but it is important to note that their effectiveness is not a long-term solution (Morin & Wooten, 1996). In addition, pharmacological treatments can be expensive and can also have significant side effects even with short-term use, which can outweigh the benefits they provide (Morin & Wooten, 1996; Bootzin & Perlis, 1992).

Psychological interventions. Psychological interventions have been extremely successful, with 60 to 80% of individuals reporting reliable and consistent improvement in their sleep length and quality following treatment (Lichstein & Reidel, 1994; Morin et al., 1994; Morin & Wooten, 1996; Murtagh & Greenwood, 1995). These include psychoeducation (sleep hygiene), behavioral (stimulus control), and cognitive therapies.

Pharmacological versus Psychological Interventions

The efficacy of pharmacological and psychological interventions is well documented (Ohanyon et al., 1999; Ohanyon et al., 2001). Smith, Perlis, et al. (2002) conducted a meta-analysis of pharmacotherapy and behavioral treatments in individuals with insomnia. Their results indicated moderate to large weighted effect sizes for subjective assessments of sleep variables. There were no significant differences in the effect sizes of treatments between pharmacological (P) and behavioral (B) interventions in terms of sleep duration ($P = .84$, $B = .46$), sleep quality ($P = 1.20$, $B = 1.44$), and wake

time ($P = .89$, $B = 1.03$), and number of times woken ($P = .97$, $B = .83$), indicating that both forms of treatment effectively treated sleep difficulties. While there were no significant differences in the majority of pharmacological treatments and behavioral treatments, sleep latency onset showed greater reductions with behavioral interventions. Thus due to potential for negative side effects of pharmacological interventions and similar efficacy, psychological interventions may be more appropriate.

Psychological Treatment Types

Sleep hygiene. Sleep hygiene involves basic information about how to promote good sleep and inhibit bad sleep (American Sleep Disorders Association, 1990). Sleep hygiene also promotes lifestyle changes to encourage healthy sleep habits and patterns. Sleep hygiene typically involves psychoeducation about the importance of consistent sleep schedules, food intake to avoid at night, negative effects of reduced sleep, avoidance of stressful activities before bed, exercise habits, how to maintain a positive sleep environment such as minimal lighting, and avoidance of naps (Nehlig et al., 1992; Reidel, 2000; Roehrs & Roth, 1997; Tiffin, Ashton, Marsh, & Kamali, 1995). Individuals are taught to limit naps to no more than one hour, only use their bedroom for sleep, and to make sure that their bedroom is comfortable (Bootzin & Epstein, 2000).

The sleep hygiene guidelines have clinical support (Morin et al., 1994; Murtagh & Greenwood, 1995) are used frequently by practitioners (Lack, 1986). Utilizing sleep hygiene interventions alone show evidence of efficacy 12 months post treatment (Hauri, 1993). The guidelines include traditional information about sleep hygiene as well as guidelines regarding circadian rhythms and exposure to natural and bright lights (Bootzin

& Nicassio, 1978; Lack, 1986). It is important to educate individuals about sleep hygiene as well as its implementation.

Tan, Healy, Gray, and Galland (2012) evaluated the efficacy of a sleep hygiene intervention with children and adolescents aged 10 to 18. A pre-post design was used to assess changes in sleep hygiene knowledge, sleep quality, and daytime impairment following a sleep hygiene intervention. Results showed a small, but statistically significant improvement in sleep hygiene practices following the intervention as well as reductions in daytime fatigue.

Bosie, Efera, and Hailu (2012) evaluated medical students' sleep hygiene knowledge and practices. Their study was cross-sectional and compared students in their second and sixth years of school. They found significant differences between the groups regarding their sleep hygiene and attitudes toward sleep, but that overall students' awareness, perceptions, and practices relating to sleep were low. These results highlight a general lack of knowledge relating to sleep hygiene and researchers suggest that educational strategies to improve sleep hygiene are needed.

While sleep hygiene is a modifiable factor that can impact the efficiency of an individual's sleep length and sleep quality, knowledge alone is insufficient (Morgenthaler et al., 2007). Knowledge acquired regarding sleep hygiene must also be applied to daily life, and many studies only assess knowledge and not sleep hygiene practices. Holbrook, White, and Hutt (1994) observed that increases in sleep hygiene awareness are not always found to change sleep hygiene practices, which would suggest that other factors impacting the application of knowledge needs to be identified.

Stimulus control. Stimulus control is a method or series of techniques meant to increase the association between the bedroom and the onset of sleep (Morin & Wooten, 1996). Numerous studies have indicated that stimulus control is one of the most effective treatments for treating sleeping difficulties (Engle-Friendman, Bootzin, Hazelwood, & Tazo, 1992; Lack, 1986; Morin et al., 1994; Morin & Wooten, 1996; Murtagh & Greenwood, 1995). It suggests how to decrease sleep difficulties in ways that are empirically supported and increase associations between the bedroom and sleep by limiting activities that occur within an individual's bedroom (Morin et al., 1994; Morin & Wooten, 1996; Murtagh & Greenwood, 1995) and frequently used in clinical practice (Lack, 1986).

Many times, individuals will begin to associate their bedroom with activities that are not related to sleep such as homework, watching television, or reading, which can cause sleep difficulties. The idea underlying stimulus control techniques is that when individuals have difficulties falling or staying asleep, it commonly provokes anxiety about sleep in the individual. This anxiety can exacerbate the sleep difficulties and can create more permanent sleep concerns. The goal of stimulus control is to stop individuals from trying too hard to fall asleep and provoking anxiety, which is associated with their bedroom (Bootzin & Nicassio, 1978).

Instructions regarding sleep and the context of the bedroom are intended to instill a stronger association between sleep and the bedroom, while weakening associations between the bedroom and other activities such as studying or watching television (Bootzin & Epstein, 2000). This may be done through instructions such as getting out of bed and going into another room if the individual is unable to fall asleep after 15 minutes

and only returning to the bedroom when they become sleepy again, refraining from naps during the day, and using the bedroom for sleep and sex only. Individuals are discouraged from watching television, eating, or reading in their beds (National Sleep Foundation, 2006a).

Multiple meta-analysis reviews recommend stimulus control as an effective intervention in the treatment of insomnia, especially relating to sleep latency onset and ability to remain asleep all night (Engle-Friedman et al., 1992; Lack, 1986; Morin et al., 1994; Morin & Wootin, 1996; Murtaugh & Greenwood, 1995). McCluskey, Milby, Switzer, Williams, and Wooten (1991) evaluated multiple outcome studies and suggested that interventions utilizing stimulus control and relaxation techniques had greater results than other forms of sleep interventions at one month post-treatment.

Sleep restriction. Oftentimes, individuals will spend long amounts of time in bed attempting to regain lost sleep, only to become frustrated that they are not sleeping. Sleep restriction is designed to break associations between the bedroom and sleep difficulties by limiting the amount of time a person spends in bed to approximately the average amount of time they spend asleep, which is determined through sleep logs prior to treatment (Morgenthaler et al., 2007; Morin et al., 2006; Spielman, Saskin, & Thorpy, 1987). Individuals are asked to keep a log to determine how much time they are spending asleep in their bed at night and are then instructed to only spend that length of time in bed whether they are sleeping or not. For example, a person who is only sleeping four hours per night will be instructed to stay in bed for only four hours per night. The amount of time in bed will be increased by 15-20 minutes after the person is spending at least 85% of their time in bed asleep, which is reaching sleep efficiency (Morin & Wooten, 1996).

This process continues until the person is sleeping throughout the night and obtaining an appropriate amount of sleep.

This treatment impacts homeostatic sleep by regulating the length of time in bed to that needed to sleep as well as eliminating naps. In addition, a person's circadian sleep drive can become irregular, resulting in sleep disturbances. By setting a consistent sleep and wake time, the individual's circadian sleep-wake cycle may begin to normalize. This treatment may initially result in sleep deprivation, but once the sleep schedule becomes more regular, it will make the onset of sleep easier and will lead to increased sleep length (Morin et al., 1994; Murtagh & Greenwood, 1995).

Hoch and colleagues (2001) compared the efficacy of a sleep hygiene intervention and a sleep hygiene plus sleep restriction intervention in older adults. Efficacies of the interventions were evaluated by improvement in sleep consolidation, meaning long and uninterrupted sleep, and quality. Results indicated that the sleep hygiene with sleep restriction had a 6.1% improvement in sleep efficiency compared to 1.8% in the sleep hygiene alone group. Interestingly, while the sleep hygiene and restriction group had greater improvements in sleep quality and length, those in the sleep hygiene group alone reported more significant improvements in mood and daytime well-being. A similar study by Taylor, Schmidt-Nowara, Jessop, and Ahearn (2010) compared an intervention with sleep hygiene alone and sleep hygiene plus sleep restriction and hypnotic withdrawal. Results showed that those in the sleep hygiene with sleep restriction and hypnotic withdrawal had greater improvements in falling asleep and sleeping through the night, which continued at six and 12-month follow-ups. Overall sleep restriction can be a

beneficial form of treatment for sleep related issues, but is typically used with other methods.

Relaxation therapy. Relaxation therapy promotes sleep through techniques designed to calm individuals, placing them in a restful state conducive to sleep. Examples include muscle relaxation, meditation, biofeedback, and breathing techniques that will promote faster onset of sleep as well as increased length of sleep (National Sleep Foundation, 2006a). These techniques require practice in order to promote efficacy and improve ability for onset of relaxation. Relaxation therapy is empirically supported, but results indicate it is less effective than other treatment options such as stimulus control (Morgenthaler et al., 2006; Morin et al., 2006).

Evaluation of relaxation technique's impact on sleep has shown that it effectively decreases the amount of time spent before falling asleep (Bootzin & Perlis, 1992; Friedman et al., 1991; Hyrshko-Mullen, Brockl, Haddock, & Petterson, 2000; Morin et al., 1994; Morin & Wooten, 1996). One potential limitation of this technique is that heightened arousal is not problematic for all individuals with sleep difficulties and therefore would not be applicable as a treatment option for all individuals with sleep difficulties. Also, results regarding efficacy of relaxation techniques and the relationship between arousal and sleep are mixed (Bonnet & Arand, 1998; Good, 1975)

Cognitive-behavioral therapy (CBT). The utilization of cognitive-based techniques for sleep difficulties has increased over time and is a common component in the treatment of sleep difficulties. In fact, one of the strongest predictors of poor sleep in the United States is the frequency of concern, organization, and consideration of important matters prior to bedtime (Gellis & Lichstein, 2009). Cognitive factors

including rumination and faulty beliefs can exacerbate sleepiness. Morin, Kowatch, Berry and Walton (1993) found that treatments that focused on reducing dysfunctional cognitions lowered the amount of time it took individuals to fall sleep, decreased the frequency of times they woke up throughout the night, and also improved sleep efficiency (getting restorative sleep). Another key aspect of cognitive interventions includes evaluation and alteration of personal expectations of sleep (Bootzin & Perlis, 1992), which may impact the achievement of sleep.

Cognitive behavioral therapy for insomnia (CBTi) incorporates several techniques together to form a specialized treatment program. It includes sleep restriction, stimulus control, cognitive restructuring, sleep hygiene, and relapse prevention (Morin, 1993; Morin, 2003; Morin, 2006). It is considered a first-line treatment for insomnia and may improve long-term sleep more than medications (National Institutes of Health, 2005). Bootzin and Perlis (1992) found that cognitive therapy was highly effective when directing interventions to evaluate and alter individual expectations. Unfortunately, CBTi is underutilized due to a lack of providers with specialized CBTi training and limited insurance reimbursement (Perlis, Smith, Cacialli, Nowakowski, & Orff, 2003; Perlis & Smith, 2008).

Cognitive treatments can also be administered in various formats. The use of the Internet to administer cognitive interventions is being explored so that treatment will be more accessible for clients. Several studies have shown that Internet interventions for insomnia are effective and practical (Ritterband, Thorndike, Cox, et al., 2009; Strom, Patterson, & Anderson, 2004; Suzuki et al., 2008; Vincent & Lewycky, 2009). Ritterband et al. (2012) tested the efficacy of an Internet-based CBT intervention, Sleep

Healthy Using The internet (SHUTi; Ritterband, Thorndike, Gonder-Frederick, et al., 2009) in cancer survivors. The intervention of this study incorporated six modules that include information about sleep restriction, stimulus control, sleep hygiene, cognitive restructuring for faulty beliefs, and problem prevention strategies to avoid relapse. Participants were randomly assigned into the experimental and control groups. Results indicated that the SHUTi program was an effective intervention to treat insomnia in cancer survivors. The study produced clinically meaningful improvements in insomnia and sleep efficiency.

A meta-analysis of CBT in a self-help format was explored to determine efficacy and dropout rates (Ho et al., 2014). Analysis of relevant publications revealed that significant improvements with effects sizes of 0.80 for sleep efficiency, 0.66 for sleep onset latency, and 0.55 for wake after sleep onset at immediate post-treatment. Compared to waitlist participants, improvements in sleep were stable at one and three months follow up. Analyses also indicated that those in CBT self-help interventions had significant improvements when telephone consultation was added, indicating that although self-help treatments can be beneficial, individuals will show greater improvement with interaction or consultation with others.

One important limitation of cognitive treatments is that in order to use these approaches, clients must have a certain level of cognitive functioning so those that are very young, developmentally delayed, or suffering from certain medical conditions such as dementia would not be appropriate for this treatment intervention.

Circadian rhythm management. The circadian rhythm is the 24-hour day-night cycle that plays a role in the quantity and quality of sleep an individual acquires (Lavie,

1986). As previously stated, circadian rhythm influences many human functions and can cause significant impairment if altered. This is especially true in relation to the sleep-wake cycle. When individuals' circadian rhythm is stable, they will have better sleep length and quality. Unfortunately, lifestyles have changed drastically over time and are typically irregular in regards to sleep and wake times. Therefore, the circadian rhythm is not kept stable (Burgess & Eastman, 2004; Burgess & Eastman, 2006; Cajochen, Jewett, & Dijk, 2003). Discrepancies between a person's circadian clock and social schedules can result in poor sleep quality, decreased alertness during the day, decreased emotional stability, and poorer psychological well-being (Giannotti et al., 2002; Thorleifsdottir, Bjornsson, Benediktsdottir, Gislason, & Kristbjarnarson, 2002; Wittman, Dinisch, Merrow & Roenneberg, 2006; Wolfson & Carkadon, 1998).

Many college students get less sleep during the week and more on weekends. In addition, college students' sleep habits are highly variable in that class times, work times, activities, and appointments vary day to day. One way to stabilize a person's circadian rhythm is by going to bed each night at the same time and waking at the same time every morning, regardless of whether it is a weekend, weekday, or holiday (Czeisler et al., 1981). Takasu, Takenaka, Fujiwara, and Toichi (2012) found that by regularizing participants' sleep-wake times, they had decreased rates of tension-anxiety, fatigue and anger-hostility, and that the effects lasted for six days after they resumed their irregular sleep schedules.

Sleep Intervention Programs for College Students

Although there are multiple interventions to treat sleep difficulties, college students represent a subset of the population with unique challenges. Transition to college

is overwhelming for many individuals (Dahl & Lewin, 2002; Fuligni & Hardway, 2006) in addition to the physiological and cognitive changes that occur at this developmental period. Students have to adjust to living independently as well as increased pressures of school, time management, socialization, and daily living. College students are also likely to be living under conditions that are not seen in the population such as living in a dorm or having multiple roommates with varying schedules. The often-stressful adjustment to college life creates concerns in various aspects of life that can negatively impact sleep. It is imperative to consider these factors in regards to effective interventions.

Several interventions have been applied to college populations, with mixed results. Students may not be aware of techniques or activities that promote healthy sleep and functioning. When discussing healthy sleep patterns, typically entailing eight hours of sleep, the last two hours of sleep are the most important for integrating new information (Smith & Lapp, 1991). If individuals are not on a sleep schedule or if they are unable to get the allotted sleep amount that is generally recommended, they will not receive the benefits that accompany a full night sleep.

CBT-I. Taylor et al. (2014) evaluated the efficacy of a CBT-I intervention in a college student population. Those in the intervention group received six sessions of CBT-I compared to a waitlist control group. The intervention contained information on stimulus control, sleep restriction, sleep hygiene, relaxation training, and cognitive restructuring. The intervention had positive and long-lasting effects with participants showing improvements at post treatment for sleep efficiency, dysfunctional sleep beliefs, amount of times woken during the night, average time spent awake after initiating sleep,

insomnia severity, sleep onset latency, sleep quality, and fatigue. The results with the college population replicate studies on the efficacy of CBT-I in other populations.

While this intervention demonstrated improvement, the variability of college students' schedules make repeated therapy unlikely or problematic. Even six sessions may be too much for students to attend given their academic, financial, social, and personal constraints on time and energy.

The Sleep Treatment and Educational Program for Students (STEPS).

Brown, Buboltz, and Soper (2006) created a psychological intervention effective in improving sleep in college students. This program includes a 15-minute, scripted oral presentation to highlight the frequency and importance of sleep, potential consequences that accompany lack of sleep, and poor sleep habits and how they impact the various areas of life. Handouts relating to sleep hygiene, stimulus control instructions, and diet and nutrition were also provided.

The primary focus of this program is sleep hygiene and information and instructions on the impact of caffeine use, diet, exercise and environmental factors. The effectiveness of STEPS was evaluated through the use of the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) given six weeks after the intervention. The program significantly improved sleep quality and lowered sleep disturbances for those in the STEPS group compared to the control group (Brown et al., 2006). However, Calvert (2012) found that the STEPS program did not result in significant improvements in sleep for college students.

Research on the STEPS program provides mixed support for the use of a brief intervention to assist students with sleep difficulties. However, the conflicting results

suggest a need for further evaluation. It may also be that while sleep hygiene can positively impact sleep, additional areas need to be addressed in order to increase efficacy.

The Enhanced STEPS program. The Enhanced STEPS program (Calvert, 2012) included all of the information, prompts and handouts from STEPS, but also introduced instructions to students about cognitive techniques, such as ruminating thoughts, that may increase sleep difficulties. Techniques included thought stopping and relaxation techniques. The thought stopping techniques were internal speech and distraction including instructions to shout, “stop” internally, a rubber band technique, and redirection of thoughts when ruminating about not sleeping and provoking anxiety. Relaxation techniques were intended to reduce anxiety, promote relaxation, and prepare the body for sleep and included diaphragmatic breathing, mental imagery, and progressive muscle relaxation.

Calvert (2012) found that neither the STEPS nor the Enhanced STEPS programs improved sleep quality, sleep length, sleep hygiene practices or sleep hygiene awareness. Calvert (2012) also evaluated potential factors that may interact or influence the outcome of intervention, specifically participant’s reactance and motivation. Results indicated that both reactance and motivation did not play a significant role in the effectiveness or implementation of psychoeducational information from the interventions.

The Enhanced STEPS intervention addressed reactance and motivational factors in addition to sleep hygiene, but did not significantly impact sleep. Other studies have indicated that the addition of cognitive factors is important in sleep interventions (Taylor

et al., 2014). It may be that cognitive techniques utilized in their study were not effective within this population or that other methods are better suited to college students.

Other sleep intervention programs. Quan, Anderson, and Hodge (2013) administered an Internet based education program to college students intended to improve sleep literacy. Their program was cultivated using information from Harvard Medical School's sleep education website (<http://www.understandingsleep.or>). Students from four sections of introductory psychology were eligible to participate, with two sections offered links to the sleep education website without structured presentation of information and two sections were given the opportunity to utilize the specialized site set up by the researchers that included structured lectures about external factors influencing sleep, sleep and cognition, biological rhythms, and sleep disorders followed by a short quiz on the information. All sections took quizzes to determine if learning occurred. At the end of the semester-long study, results showed that a significant number of students in the intervention group changed their sleep habits, had more consistent wake times, and got better sleep compared to the control group. This demonstrates the impact that providing knowledge can have on student outcomes of sleep and that more directive presentations of information can improve student acquisition of information and application of the information.

Efficacy of Sleep Interventions

Morin and associates (1994) found that sleep restriction and stimulus control were the most effective treatments for insomnia and sleep related problems. However, according to the National Sleep Foundation (2006a), there is little evidence to support the efficacy of other treatments such as sleep hygiene or stimulus control, despite the high

prevalence of their use in the treatment of sleep related disorders or difficulties. The National Sleep Foundation (2006a) instead found that there is evidence for treating sleep problems with benzodiazepine receptor agonists and cognitive behavioral therapy. Results regarding the efficacy of treatments are mixed (Brown et al., 2006; Calvert, 2012) and no form of treatment has been agreed upon as the best method of treatment.

When assessing the efficacy of interventions, many factors can impact results. One of the primary concerns is the format and validity of the information collected. Individuals are not always the most reliable sources of information. There are instances in which an individual perceives being awake for extended periods of time throughout the night, but when evaluated by professionals, the results indicate no difficulties with sleep (Marano, 2003).

Buboltz et al. (2009) evaluated sleep patterns of undergraduate students from three universities. The results indicate that students had a misperception regarding the amount of sleep they acquire. The average difference between the length of sleep on weekdays versus weekends was only 42 minutes, yet 70% of students reported feeling that they do not get enough sleep during the week and only 40% reporting inadequate sleep on weekends. Participants also consistently underestimated the amount of sleep they received. If an individual's perception is that they are lacking sleep, they are likely to believe they should feel tired and that may impact their performance, motivation and achievement. Also, Buboltz et al. (2009) suggested that the belief that students should feel tired following their perception of insufficient sleep can result in consumption of foods aimed at promoting energy, procrastinate or ignore school or life responsibilities, or decide to take a nap, all of which can impact sleep.

Self-report assessments also leave room for socially desirable responding or giving researchers responses the participant believes they want. Social information processing theory asserts that people will use information from their social environment to determine outcomes of behaviors (Salancik & Pfeffer, 1978). Humans are social creatures and will learn information about normative behaviors through observation of others (Hogg, 2010). If research participants are involved with an intervention aimed at sleep, they are likely to assume that they should be sleeping better and respond accordingly, regardless of the accuracy of the information they are providing. Forquer et al. (2008) observed that sleep difficulties in college students are more prominent than indicated in self-report measures commonly used in evaluating sleep due to a desire to provide responses they feel others expect or hope to get as well as fear of judgment when responding to questions, especially those asking about alcohol or substance use, sexual encounters, or other areas perceived to be sensitive or private in nature. The International Classification of Sleep Disorders (ICSD-2; American Academy of Sleep Medicine, 2005) suggests using actigraphic data be utilized to document disparities between subjective and objective data regarding sleep.

Finally, faulty sleep beliefs provide students with information that is often inaccurate and may make ameliorating sleep problems less likely (Machado et al., 1998). Different beliefs about sleep and sleepiness impact how individuals cope with sleep troubles, the effectiveness of interventions, and motivation to perform certain activities that can affect their sleep (Digdon, 2008). Many times people can have inaccurate ideas about the contributing factors affecting sleep. For instance, a person may be aware of the benefit of napping on their performance, but be unaware of the impact long naps can have

on nighttime sleep or may feel alcohol consumption assists with the onset of sleep, but does not recognize that it negatively impacts sleep length and quality (Diaz-Morales, Prieto, Banneno, Mateo, & Randler, 2012). Another common misconception is that individuals fail to recognize that physical activity and exercise performed early in the day improves sleep at night whereas caffeine consumption disrupts sleep (Ohayon et al., 2001).

Digdon (2008) found that circadian preference was related to beliefs about how to appropriately deal with difficulties sleeping. Owls believed that exercise was less effective at ameliorating fatigue and that napping was the best way to deal with sleepiness, followed by coffee consumption. Digdon (2008) suggested that interventions incorporate evaluation of student beliefs in addition to education, adding that oftentimes people may be aware of information, but believe that it does not apply to them. Also, all participants in the study identified ways in which they coped with sleepiness and sleep problems, even though some participants' perceptions of effective coping strategies for sleep difficulties were inaccurate. This shows that students feel a level of control over their difficulties and that they feel they are able to change their sleep patterns.

Differences in beliefs also vary depending on circadian preference type. Many college students describe themselves as owls and are more likely to support false beliefs regarding behaviors that are incompatible to sleep, sleep-wake cycle behaviors, and thoughts and attitudes about slumber (Adan, Fabbri, Natale, & Prat, 2006).

Physiological Sleep Assessment

Actigraphy is an objective measure of activity and sleep utilizing accelerometers and memory storage in a device that is typically worn on the wrist. These devices use

advanced algorithms to calculate and evaluate participants' sleep and activity.

Actigraphy was introduced in the 1950's to evaluate physiological disorders in children using mechanical sensors (Tyron, Bellak, & Harsen, 1991). Technology has come a long way since then and Actigraphy devices provide long-term, objective data about a person's activity and sleep patterns through the use of advanced algorithms to identify sleep versus wakefulness (Martin & Hakim, 2011). In 1995, the American Academy of Sleep Medicine (AASM) identified Actigraphy as a useful tool to research sleep, although there was uncertainty about its clinical utility. In 2002, the AASM expanded its response to include the use of actigraphy as a measurement of sleep across clinical settings. As of 2007, research has demonstrated strong support for the use of actigraphy in clinical settings and applications such as evaluating circadian rhythm disorders, insomnia, hypersomnia, and obstructive sleep apnea (Morgenthaler et al, 2007).

Recently, there has been a vast increase in consumer-grade activity devices. These devices can provide information about individual activity and sleep monitoring. Use of Actigraphy is valid and reliable (Littner et al., 2003), although in order to achieve the best results, it may be beneficial to have individuals wear the devices for multiple nights (Tworoger, David, Vitiello, Lentz, & McTieman, 2005). In order to utilize home-based assessment of sleep with wrist actigraphy, it is suggested that participants wear the device for one week and that multiple forms of information should be used in addition to the actigraphic data (Martin & Hakim, 2011).

In terms of validity of sleep measurement, measurements from consumer level devices are similar to the measurements from expensive, research grade actigraphy devices (Montgomery-Downs, Insana, & Bond, 2012). Accelerometers have been utilized

in various research and medical studies to assess participant's physical activity and energy expenditure implicit and sleep, but they have not been utilized as frequently due to the associated cost and difficulty of use, including a required knowledge of software and computer programming to appropriately collect and analyze the information (Corder et al., 2007; John, Tyo, & Bassett, 2010). More recent technological advances have allowed for consumer grade accelerometers to be created that are more reasonably priced and user friendly.

Ferguson, Rowland, Olds and Maher (2015) compared information gathered by several consumer level activity monitors with information gathered through two research-grade accelerometer devices to evaluate their validity for use in research. The study participants wore the devices in free-living conditions, meaning that they were not asked to change their location, behaviors, or typical daily patterns. The overall results indicated that the consumer grade devices were strongly correlated ($r > .8$) with the medical grade devices when evaluating step count and amount of time asleep.

Thun et al. (2012) used actigraphy to validate several morningness-eveningness inventories. Their study had participants wear the actigraphic devices for seven days in addition to completing subjective assessments of morningness-eveningness. The results showed that objective actigraphic data corresponded well with the subjective assessments of sleep duration, bed time, and rise times. By utilizing objective measures to validate subjective measures, a significant amount of method bias was avoided (Fiske, 1982).

Meyer and Boll (2014) concluded that although consumer grade activity and sleep monitors are less precise than those used in medical research, the advantages of acquiring information in real world, free-living situation makes the appeal and applicability of

consumer grade use a viable option for researchers. In addition to being able to gather information in a real world setting, as opposed to a laboratory setting, data can be acquired over longer periods of time. This provides more realistic information about sleep patterns and potential concerns.

Actigraphy Use for Efficacy of Interventions

Actigraphy has been used to evaluate the success of both pharmacological (Wilson, Rich, Rich, Potokar, & Nut, 2004) and behavioral (Edinger, Wohlgemuth, Radtke, Marsh, & Quillian, 2001; Friedman et al., 2000) clinical trials for the treatment of insomnia. Several studies have documented the use of actigraphy with older adults to determine the outcome of pharmacological interventions (Alessi et al., 2005; Ancoli-Israel et al., 2003). The American Academy of Sleep Medicine concluded that actigraphy was a valuable research tool for the study of sleep including clinical populations and those with circadian rhythm disorders and insomnia (Morgenthaler et al., 2007).

The International Classification of Sleep Disorders (ICSD-2; American Academy of Sleep Medicine, 2005) lists actigraphy as a diagnostic tool and provides guidelines for its use in the evaluation of sleep. Their guidelines state that data should be collected for a period of seven or more days and that participants sleep patterns be evaluated prior to assessment as a baseline for comparison. It also suggests that subjective and objective assessment of sleep be compared and evaluated to look for inconsistencies.

El-Sheikh and colleagues (2007) used actigraphy to assess the relationship between marital conflict and emotional security on the quality and duration of sleep in elementary school students. Results indicated that the relationship between marital conflict and sleep was mediated by emotional security, and participants with increased

sleep disruptions performed worse academically, emotionally, and behaviorally. Studies also used actigraphy to evaluate sleep in later life, especially in older individuals that are institutionalized or in nursing homes, to evaluate the effectiveness of non-pharmacological interventions (Ancoli-Israel et al., 2003; Alessi et al., 2005).

Actigraphy Use in College Population

The use of actigraphy can be highly advantageous in the evaluation of sleep interventions through the elimination of reporter bias. Actigraphy is typically used for one to two weeks to objectively assess aspects of sleep, including duration and quality. Although some researchers have found discrepancies between the objective data collected through actigraphy and the subjective, self-report data of participants (Jean-Louis et al., 1999; Verbeek, Klip, & Declerck, 2001), many studies indicated that they are reliable and valid measures of sleep that can be applied in a real world context. Actigraphy is especially useful for daily evaluations and evaluating changes over a period of time (Drake, Roehrs, & Roth, 2003), such as the evaluation of changes following an intervention.

The Present Study

Based on the review of literature, the present study evaluated the efficacy of a psychoeducational sleep intervention for college students through self-report and physiological measures. The present study also attempted to fill a gap in the literature by investigating intervention efficacy in a college population with the use of actigraphy. In accordance with guidelines from the American Association of Sleep and Medicine for treatment management (Morgenthaler et al., 2007), participants wore a wrist actigraphic

device to monitor sleep and activity throughout the study. The study also furthered research regarding the efficacy of various methods of interventions aimed at increasing sleep length and quality. The results of this study have implications for college students' well-being as well as integrating physiological data with psychological interventions.

Transitioning to college is often accompanied by a variety of new stressors and challenges. They can make one's life extremely chaotic and stressful while trying to adjust, especially during the first year of college (Edwards, Hershberger, Russell, & Markert, 2001). College students strive to find a balance between school, work, spending time with friends, as well as getting adequate sleep; however, many find that they have reduced sleep following the transition to college (Carskadon & Davis, 1989; Lund et al., 2010). This may be especially true for first year students since they report poorer sleeping than second year students (Suen, Hon, & Tam, 2008).

Brown, Buboltz, and Soper (2002) have provided the key ingredients for a student sleep education program. The goal of the current study was to extend the research in this area and develop an updated sleep education program for college. Additionally, both objective and subjective data were collected to assess the impact of the program. Student's anxiety about sleep was also evaluated as a potential factor impacting implementation of knowledge to improve sleep length and quality.

Many interventions aimed at sleep difficulties involve sleep hygiene awareness and practices. Although these are beneficial, upon closer examination of the research studies, many increase student knowledge, but often are not reflected in behaviors. Students are acquiring knowledge, but other factors prevent them from incorporating that information into their daily living to improve sleep length and sleep quality. One major

barrier to the implementation of sleep hygiene practices is worry or anxiety. With all of the new changes, pressures, and responsibilities students face in many areas of their lives, they are likely to generalize that anxiety to other areas, including sleep. Individuals that are stressed about their sleep are less likely to get sufficient and restful sleep.

This study adapted a psychoeducational program that will be administered in a group format. The intervention included information and application of sleep hygiene awareness and cognitive techniques aimed at alleviating sleep difficulties in college students. While several studies have looked at these factors in part or whole, results pertaining to effectiveness are mixed (Brown et al., 2002; Calvert, 2012; Lund et al., 2010; Murtagh, & Greenwood, 1995; Vail-Smith et al., 2009). Student interventions frequently result in increased sleep hygiene knowledge, but are often not implemented into participant's lifestyle. By assessing individuals' anxiety about sleep and incorporating cognitive features in addition to sleep hygiene awareness and practices, this study hoped to increase the effectiveness of sleep interventions.

Hypotheses

Hypothesis 1A

Participants in the treatment group will have significantly better sleep quality compared to participants in the control group as measured by the total score of the Pittsburgh Sleep Quality Index (PSQI; Buysse, et al., 1989) at Phase III.

Hypothesis 1B

Participants in the treatment group will have significantly greater sleep length compared to participants in the control group as measured by self-report sleep logs and objective actigraphy data at Phase III.

Hypothesis 1C

Participants in the treatment group will have significantly greater amount of time in restful sleep as measured by actigraphy.

Justification for Hypothesis 1 (1A, 1B, 1C)

Research consistently indicates improvements in sleep length and quality following psychological interventions (Lichstein & Reidel, 1994; Morin & Wooten, 1996). Brown, Buboltz, and Soper's (2006) STEPS program, which is adapted for this study, was found to be an effective intervention to improve college students' sleep. Sleep hygiene guidelines in interventions have shown clinical support for increasing sleep length and quality (Lack, 1986) and have maintained improvements over extended periods (Hauri, 1993). As sleep length increases, the amount of time spent in REM or deep, restorative sleep also increases (Carskadon & Dement, 2011).

Hypothesis 2

Participants in the treatment group will not have significant differences between their subjective and objective measures of sleep length as measured by actigraphy and sleep logs.

Justification for Hypothesis 2

Although it is not perfect, research indicates that actigraphy data is an objective and reliable measure of sleep (Montgomery-Downs et al., 2012) and is considered a

useful tool for the assessment and tracking of sleep by the American Academy of Sleep Medicine (2005). Previous research also supports that actigraphy data is similar to subjective assessments of sleep duration, bed time, and wake times (Thun et al., 2012).

Hypothesis 3A

Participants in the treatment group will show significant improvement on their sleep hygiene awareness between Phase II and Phase III while controlling for Phase I scores as measured by the Sleep Belief Scale (SBS; Adan et al., 2006).

Hypothesis 3B

Participants in the treatment group will show significant improvement on their sleep hygiene practices between Phase I and Phase III as measured by the Sleep Hygiene Index (SHI; Mastin, Bryson, & Corwyn, 2006).

Justification for Hypothesis 3 (3A, 3B)

College students generally have poor sleep hygiene and sleep habits (Onyper et al., 2012; Vela-Bueno et al., 2009). In fact, Hicks, Lucero-Gorman, Bautista, and Hicks (1999) found that on average, students only scores 50% on tests of sleep hygiene knowledge, which emphasizes a need to educate this group of individuals about sleep hygiene practices. College students are often unaware of the impact their behaviors will have on their sleep and may not attribute sleep difficulties to their lifestyle including variable sleep schedules (Trockel et al., 2000), caffeine ingestion (Malinauskas et al., 2007), alcohol use (Galambos et al., 2009), and several other factors addressed through sleep hygiene.

Hypothesis 4A

Participants with lower levels of anxiety about sleep will have better sleep quality, as measured by the total score on the PSQI (Buysse, et al., 1989), compared to individuals with higher levels of anxiety about sleep. The total score on the Anxiety and Preoccupation About Sleep Questionnaire (APSQ; Tang & Harvey, 2004) will measure anxiety about sleep.

Hypothesis 4B

Participants with lower levels of anxiety about sleep will have longer sleep length, as measured by self-report and actigraphy data, compared to individuals with high levels of anxiety about sleep. The total score on the APSQ (Tang & Harvey, 2004) will measure anxiety about sleep.

Justification for Hypothesis 4 (4A, 4B)

College students have increasingly high levels of stress when transitioning to college and juggling new responsibilities and concerns (Dahl & Lewin, 2002; Fuligni & Hardway, 2006; Loessl et al., 2008). This increased anxiety and stress will result in undesirable effects on individual's sleep quality and length (Buboltz et al., 2001; Buboltz et al., 2006). Additionally, individuals that are struggling with sleep often become concerned about their inability to sleep, which produces more anxiety (Lichstein & Rosenthal, 1980). By ruminating about sleep, individuals are setting the stage for sleep difficulties. Those that report greater levels of stress will generally get less sleep (Hudd et al., 2000) and report symptoms of disjointed sleep (Mezick et al., 2009), poor sleep quality (Hall et al., 2008), and increased difficulties with insomnia symptoms (Gregory et

al., 2006). Therefore, those with decreased anxiety about sleep are more likely to report increased sleep length and sleep quality.

Hypothesis 5

Participants in the treatment condition will have significantly lower fatigue as evidenced by significantly lower scores on the Chalder Fatigue Scale (CFQ; Chalder et al., 1993) at Phase III.

Justification for Hypothesis 5

Insufficient sleep consists of more than just the length or quality of an individual's sleep and can be related to health behaviors, attitudes, and beliefs (Grandner, Jackson, Gooneratne, & Patel, 2014). Many studies indicate that poor sleep results in increased fatigue throughout the day (Fuligni & Harway, 2006; Kyle et al., 2010; Taylor, Vathauer, et al., 2013), which can impact overall functioning. The CFQ provides an overall measure of fatigue, a common symptom associated with sleep deprivation, and is anticipated to be lower following intervention.

Hypothesis 6

Participants in the treatment group will have significantly lower severity of insomnia following the intervention compared to the control group as measured by the total score of the Insomnia Severity Index (ISI; Bastien, Vallieres, & Morin, 2001).

Justification for Hypothesis 6

As previously stated, upon receiving a psychological intervention, 60 to 80% of individuals will report stable improvements in their sleep (e. g Morin et al., 1994; Murtagh & Greenwood, 1995). Insomnia symptoms include aspects of sleep length, sleep quality, functional abilities, and anxiety regarding sleep. These symptoms will be

ameliorated through the use of psychoeducational tools including sleep hygiene knowledge and practices (Morin et al., 1994; Murtagh & Greenwood, 1995) stimulus control (Lack, 1986; Morin & Wooten, 1996), and cognitive techniques (National Institutes of Health, 2005).

Hypothesis 7

Within the treatment group, there will be an interaction between anxiety about sleep, as measured by the APSQ (Tang & Harvey, 2004), and sleep hygiene knowledge, measures by the SBS (Adan et al., 2006), and practices, measured by the SHI (Bastien et al., 2001). Participants with lower levels of anxiety about sleep will have greater sleep hygiene knowledge and hygiene practices compared to participants with higher levels of anxiety about sleep.

Justification for Hypothesis 7

Sleep hygiene is a modifiable factor that impacts the proficiency of an individual's sleep length and sleep quality, but sleep hygiene knowledge alone is insufficient (Morgenthaler et al., 2007). While there is evidence for increases in sleep hygiene awareness following intervention, Holbrook, White, and Hutt (1994) found that increases in sleep hygiene awareness are not always found to change sleep hygiene practices. When considering the college student population and the relationship between anxiety and sleep disturbances (Minkel et al., 2014; Morin & Epsie, 2003), one of the potential barriers impacting application of sleep hygiene knowledge is likely to increased stress, followed by concerns regarding an inability to attain sufficient sleep.

Hypothesis 8

Within the treatment group, there will be an interaction between sleep beliefs, as measured by the SBS (Adan et al., 2006), and sleep quality, measured by the PSQI (Buysse, et al., 1989), and sleep length, measured with actigraphy and sleep diary measures. Participants with poorer beliefs about sleep will have poorer sleep quality and length compared to participants with more accurate beliefs about sleep.

Justification for Hypothesis 8

When students have inappropriate or incorrect beliefs, they are less likely to ameliorate sleep difficulties (Machado et al., 1998). Additionally, individuals' beliefs about sleep will drastically impact their motivation to change behaviors and efficacy of interventions (Digdon, 2008). Therefore, if students have faulty beliefs, they are likely to show little difference in sleep quality or length, whereas those with appropriate beliefs about sleep are more likely to show improvements in sleep length and quality following the intervention.

CHAPTER TWO

METHOD

Design

This study employed a pretest-posttest control group design. There were two levels of intervention. One group received a psychoeducational sleep intervention that included sleep hygiene, stimulus control, and faulty beliefs about sleep to help improve their sleep quality. The second group included a control group, which included a presentation about the importance of research in psychology. All participants completed the demographic questionnaire, PSQI, ISI, SBS, SHI, CFS, and ASPQ, which took approximately 25 minutes at Phase I and Phase III. Additionally, participants completed a daily sleep log and wore an actigraphy device for three weeks, which was the duration of their participation in the study.

Participants

Participants were recruited from psychology classes at a medium sized Southeastern university in the United States. Participants were informed that their participation was completely voluntary. The university's institutional review board approved the survey packet, which consisted of a demographic questionnaire, the SBS, the PSQI, the SHI, CFS, ISI and the ASPQ. Participants completed an informed consent prior to completing the survey packet. No data was presented individually. In addition,

the informed consent documents and data were stored separately to ensure confidentiality.

A total of 119 participants were recruited to participate in this study. Of those 103 completed P-II and 99 participants attended Phase I (P-I), Phase II (P-II), and Phase III (P-III) of the study and were included in the next step of analysis. The data were then cleaned, eliminating data from participants with missing responses to survey items ($n = 3$) and underage students ($n = 1$). Therefore, there were a total of 95 participants included in the final analyses. The sample was predominately female (69%). Participants identified as Caucasian (83.5%), African American (8.2%), Hispanic (3.5%), Asian American (2.4%), Native American (1.2%), and Bi-racial (1.2%). Participants represented varying years in college, with 36.8% identifying as freshman, 27.6% identifying as sophomores, 18.4% identifying as juniors, and 13.8% identifying as seniors, and 3.3% identifying as other. Within the study sample, 42.5% lived off campus with roommate(s), 33.3% lived on campus with roommate(s), 14.9% lived with family, 4.6% lived off campus alone, 3.4% lived on campus alone, and 1.1 reported their living situation as other. Ages ranged from 18 – 40, with a mean age of 20.2 ($SD = 3.3$). The mean GPA of the sample was 3.2 ($SD = 0.5$).

Measures

Demographic questionnaire. This questionnaire included information about participants' age, gender, living arrangements, ethnicity, classification in school, and current GPA.

Pittsburg Sleep Quality Index (PSQI). The PSQI (Buysse et al., 1989) assesses sleep quality and disturbances over a one month period. It contains 19 items on a 4-point

Likert scale with responses including “*not during the past month*”, “*less than once a week*”, “*once or twice a week*”, or “*3 or more times a week*” and takes five to ten minutes to complete. It also asks individuals to indicate the actual amount of hours slept in the past month. The PSQI includes seven subscales: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Scores from the subsections are totaled to give a global sleep quality score. Scores range from zero to 21, with higher scores signifying poorer sleep quality. Buysse et al. (1989) suggests that scores above five are considered poor sleepers and that by using this cutoff, 88.5 percent of participants were correctly classified. For the purposes of this study, total scores were used to assess sleep quality.

Buysse et al. (1989) found that the PSQI is a reliable measure and showed good internal consistency ($\alpha = .83$) and test-retest reliability ($r = .85$). They also found that the subscales have moderate reliability with internal consistency ranging from .76 on subjective sleep quality to .35 for disturbance of sleep. Test-retest reliability is considered adequate, with sleep latency having the highest ($r = .84$) and medication having the lowest ($r = .65$). The PSQI was also found to have convergent and discriminant validity (Carpenter & Andrykowski, 1998). The current study demonstrated adequate reliability and internal consistency ($\alpha = .72$).

Insomnia Severity Index (ISI). The ISI (Bastien et al., 2001) is a measure of subjective sleep including difficulties falling asleep, staying asleep, sleepiness during the day and anxiety about sleep. It contains seven items on a 5- point Likert scale with responses including “*not at all*” to “*very much*”. Scores range from zero to 28, with higher scores indicative of increased severity of insomnia. According to common scoring

guidelines by Smith and Wegener (2003), participants are categorized as having no clinically significant insomnia (0-7), sub-threshold insomnia (8-14), moderate clinical insomnia (15-21), or severe clinical insomnia (21-28).

The ISI is a valid, reliable measure with good internal consistency ($\alpha = .74$ to $.78$) to assess symptoms the previous two weeks (Bastien et al, 2001). Good internal consistency ($\alpha = .83$) has also been demonstrated in college populations (Gellis & Park, 2013). The current study demonstrated good reliability and internal consistency ($\alpha = .86$).

Sleep Beliefs Scale (SBS). The SBS (Adan et al., 2006) measures individual's sleep hygiene knowledge and beliefs. It contains 20 questions on a 3-point Likert scale responses including "*positive effect*", "*neither effect*", or "*negative effect*". Scores range from 0 to 20 points, with one point given per correct answer, meaning that higher scores correspond to more knowledge and better beliefs about sleep hygiene. The scale can be divided into three factors: sleep-incompatible behaviors, sleep-wake cycle behaviors, and thoughts and attitudes to sleep.

The SBS has good psychometric properties in student populations. It was normed in a college population and has good internal consistency ($\alpha = .714$). The internal consistency was higher overall, with lower internal consistency ratings for each of the three factors: sleep-incompatible behaviors $\alpha = .633$), sleep-wake cycle behaviors ($\alpha = .525$), and thoughts and attitudes to sleep $\alpha = .471$), thus for this study, only the total score was used in the analysis. The current study demonstrated good reliability and internal consistency ($\alpha = .79$).

Sleep Hygiene Index (SHI). The SHI (Mastin et al., 2006) assesses sleep hygiene behaviors. It includes 13 questions about behaviors related to sleep on a 5-point Likert

scale ranging from “always” to “never”. Scores range from 0 to 52, with higher score indicative of poorer sleep practices.

The SHI is a reliable and valid measure of sleep hygiene behaviors. Myers et al. (2012) found that the SHI demonstrated good internal consistency ($\alpha = .74$). Test-retest reliability ($r = .71$) is also good, and the SHI is positively correlated with factors related to dysfunctional sleep behaviors and other measures of sleep hygiene, with Pearson r values ranging from .371 to .458 (Mastin et al., 2006). The SHI behaviors assessed are stable over time. The current study demonstrated adequate reliability and internal consistency ($\alpha = .76$).

Chalder Fatigue Scale (CFS). The CFS (Chalder et al., 1993) measures extent and severity of fatigue. It contains 11 items on a 4-point Likert scale. Responses range from “*less than usual*” to “*much worse than usual*.” Scores range from 0 to 33, with higher scores indicative of more severe fatigue related symptoms. There are two subscales: Mental fatigue and physical fatigue. The mental fatigue subscale consists of four questions, including “Do you have difficulty concentrating?” The physical fatigue subscale has seven questions, including “Do you lack energy?”

Chalder and colleagues (1993) evaluated the psychometric properties of the CFS. They found that the CFS demonstrated good overall internal consistency rating ($\alpha = .8903$) as well as for the mental fatigue subscale ($\alpha = .821$) and the physical fatigue subscales ($\alpha = .845$). An ROC analysis was performed and provided evidence of discriminant validity (.845). The current study demonstrated good reliability and internal consistency ($\alpha = .89$).

Anxiety and Preoccupation About Sleep Questionnaire (APSQ). The APSQ (Tang & Harvey, 2004) measures sleep-related worry. The original version contained 10 items on a 10-point Likert scale. Jansson- Fröjmark, Harvey, Lundh, Norell-Clarke, and Linton (2011) evaluated a modified version containing the original 10 items on a 5-point Likert scale ranging from “*strongly agree*” to “*strongly disagree*”. The measure is divided into two factors: worries about the consequences of sleep and worry about the uncontrollability of sleep. Scores range from 10 to 50, with high scores indicative of greater levels of anxiety.

Jansson-Frojmark et al. (2011) evaluated the psychometric properties of the ASPQ. They found that the ASPQ demonstrated high internal consistency ($\alpha = .93$). The worries about the consequences of sleep subscale ($\alpha = .91$) and worry about the uncontrollability of sleep ($\alpha = .86$) both demonstrated good internal consistency but were significantly intercorrelated ($p = .65$). The APSQ and subscales demonstrated discriminant validity between groups of normal sleepers, poor sleepers, and those with insomnia, as well as convergent validity with measures of cognitive arousal, belief about sleep, anxiety, and depression. The total score will be used for analysis in this study. The current study demonstrated good reliability and internal consistency ($\alpha = .95$).

Sleep Log. Participants completed a brief, daily sleep diary that provided information about timing of sleep, sleep length, and sleep quality. They were be asked to complete the form daily to assess sleep length and evaluate distinctions between actigraphy and self-report data. Participants turned in sleep logs on the day of the intervention and the final day of data collection.

Apparatus

Misfit Flash (Misfit, San Francisco, CA). The Misfit Flash is an actigraphy device worn on the non-dominant wrist. Actigraphic devices are used to objectively evaluate and record movement and sleep patterns and contain accelerometers that record motor activity that is analyzed to determine periods of sleep (Pillai et al., 2014). The device provides information about sleep onset, duration, wake time, and sleep quality by tracking movements and using the information to estimate sleep-wake patterns (Meltzer, Walsh, Traylor, & Westin, 2012; Sadeh, 2011). The information is digitally recording within the device and can be synced with mobile phones to store data. Research evaluating the validity of consumer grade actigraphic devices showed that data was valid and comparable to data collected by medical-grade devices (Ferguson et al., 2015). This Misfit Flash uses a battery that last approximately six months and can store data for up to 30 days.

Procedure

Recruitment. Following approval from the Institutional Review Board (IRB), participants were recruited from undergraduate courses. Participants were given a brief overview of the study and potential benefits of participation, including earning extra credit if provided by the instructor and earning a chance to win a Misft Flash device or gift card. Interested students provided contact information (name, phone number, and email) to receive further information about specific dates and times. There were two groups at different times on the same dates available for students to participate. Students signed up for the time block that was conducive to their schedule.

Phase I. Upon arrival, participants read and signed an informed consent that provided more information about the study. Participation for the study included completion of self-report measures, wearing a wrist actigraphy device and downloading the mobile phone app to sync data for three weeks, complete a brief, daily sleep log and attend a 45-minute psychoeducational seminar. Those that agreed to participate were also assigned a subject number to assure anonymity of data and responses to questionnaires. Subject numbers were matched to the data to evaluate participants' actigraphy data, demographic questionnaire, PSQI, ISI, SBS, SHI, APSQ, CFS, and sleep log data. Participants completed the demographic questionnaire and seven self-report measures before being assigned a Misfit Flash. Students were also given the sleep log and instructed on how to complete the instrument. They were asked to complete the log daily throughout the study. Afterwards, participants were given a Misfit Flash and instructed on its use. This device was selected for many reasons including comfort and ease of use. Participants were instructed to wear the device on their non-dominant wrist, taking it off only to shower, swim, or engage in other activities in which the device may be submerged in liquid. It is water resistant and did not need to be removed for washing hands, when raining, or other instances in which it may be exposed to minimal amounts of fluid. Participants were required to download the free Misfit phone application in order to access and store the actigraphy data. Actigraphy devices had a letter on them and participants completed a form with information identifying the device they were assigned, their contact information, and a signed statement explaining that the devices are being used in conjunction with participation in the research study and would be returned upon completion.

Phase II. One week after the initial meeting and receiving the actigraphy devices, participants attended a 45-minute psychoeducational seminar, which included a PowerPoint presentation, oral script, and handouts relating to the topics discussed for participants to take home. Please see Appendix A, B, and C for handouts for students, which also provide more information about areas discussed as part of the intervention. Following the psychoeducational training, participants completed the SBS and returned their completed self-report sleep log from the previous week. Participants were provided with two blank sleep logs to complete over the remainder of the study. Participants were also reminded to continue to wear their actigraphic device and that they will need to return in two weeks to complete self-report measures and return the devices to complete their participation in the study.

Treatment Condition. Individuals in the treatment group attended a 45-minute psychoeducational intervention incorporating sleep hygiene, stimulus control, and cognitive factors that impact sleep. Specifically, participants in the treatment group received information about behaviors, foods, and faulty beliefs that are likely to be impacting their sleep length and quality as well as to increase their sleep length and quality.

Control Condition. The control group attended a 45-minute psychoeducational seminar on the importance of research in psychology. The presentation briefly reviewed a total of 12 studies and explored their importance to the field of psychology and how they continue to impact the understanding and application of psychology presently.

Phase III. Students met at a pre-scheduled time and location two weeks after the intervention to return the actigraphy device and complete the PSQI, ISI, SBS, SHI, CFS,

and APSQ one final time. They also turned in their sleep log information from the previous two-week period following the intervention and completed a form relating to their actigraphy data. Participants signed in their actigraphy devices and were provided with a debriefing and an entry form to complete in order to be entered into the drawing to win one of two Misfit Flash devices and a \$100 Visa gift card.

CHAPTER THREE

RESULTS

Participants

Overall sample. Participants were 95 psychology students at a medium sized Southeastern university in the United States. The sample was predominately female (68.4%; $n = 65$), with ages ranging from 18 to 40 ($M = 20.18$, $SD = 3.19$). Participants identified as Caucasian (82.8%), African American (8.6%), Hispanic (3.2%), Asian American (3.2%), Native American (1.1%), and Bi-racial (1.1%). Participants represented varying classifications in college, with 37.9% identifying as freshman, 25.3% identifying as sophomores, 18.9% identifying as juniors, and 14.7% identifying as seniors, and 3.3% identifying as other. Within the study sample, 41.1% lived off campus with roommate(s), 34.7% lived on campus with roommate(s), 13.7% lived with family, 6.3% lived off campus alone, 3.2% lived on campus alone, and 1.1 reported their living situation as other. The mean GPA of the sample was 3.2 ($SD = 0.5$).

Control group. The control group included 49 participants, 63.3% female ($n = 31$) and 36.7% male ($n = 18$), with an average age of 19.7 ($SD = 1.5$; $Range = 18 - 24$). The control group was 81.6% Caucasian, 10.2% African American, and 8.1% Latino, Asian, or American Indian.

The control group was comprised of 44.9% freshman, 16.3% sophomores, 20.4% juniors, and 16.3% seniors, and 2% other. The majority of participants lived off campus with roommate

(40.8%), with the remainder of students living on campus with roommate (40.8%), with family (6.1%), off campus alone (8.2%), on campus alone (2%), or other (2%).

Treatment group. The treatment group included 46 participants, 73.9% female ($n = 34$) and 23.9% male ($n = 11$), with an average age of 20.7 ($SD = 4.27$; $Range = 18 - 40$). The control group was 80.4% Caucasian ($n = 37$), 6.5% African American ($n = 3$), and 8.7% Latino, Asian, or Bi-racial ($n = 4$). The control group was comprised of 30.4% freshman ($n = 14$), 34.8% sophomores ($n = 16$), 17.4% juniors ($n = 8$), and 13% seniors ($n = 6$), and 4.4% other ($n = 2$). The majority of participants lived off campus with roommate (41.3%; $n = 19$), with the remainder living on campus with roommate (28.3%; $n = 13$), with family (21.7%; $n = 10$), off campus alone (4.3%; $n = 2$), and on campus alone (4.3%; $n = 2$).

Descriptive Statistics and Reliabilities

Table 1 provides the means, standard deviations, and Cronbach's alpha for all participants on each of the measures used in this study. Table 2 presents the means and standard deviations for the control group and Table 3 presents the means and standard deviations for the treatment group.

Table 1

Means, Standard Deviations, and Cronbach's Alpha Coefficients for All Participants at Each Phase for the Scales Used in the Present Study

Variable	N	<u>P-I</u>				<u>P-II</u>			<u>P-III</u>		
		M	SD	α		M	SD	α	M	SD	α
PSQI	93	6.25	2.37	.70		-	-	-	5.57	2.79	.79
ISI	95	8.94	4.96	.84		-	-	-	7.94	4.75	.84
SBS	95	12.29	3.28	.77		14.37	4.62	.87	13.85	5.11	.89
SHI	95	27.93	6.99	.74		-	-	-	28.12	7.96	.80
CFS	95	14.76	5.61	.86		-	-	-	13.64	6.18	.92
ASPQ	94	21.13	9.17	.94		-	-	-	21.20	9.05	.94
A-SL	77	465.55	52.75	-		-	-	-	475.50	52.51	-
A-RSL	78	236.45	54.00	-		-	-	-	244.08	51.79	-
SR-SL	86	456.09	57.60	-		-	-	-	465.30	59.35	-

Note: Means and standard deviations have been converted into mean item scores on the scales. These mean item raw scores were used to calculate the alpha coefficients, as well as the other analyses in this study. $N = 95$. PSQI = Pittsburgh Sleep Quality Index; ISI = Insomnia Severity Index; SBS = Sleep Beliefs Scale; SHI = Sleep Hygiene Index; CFS = Chalder Fatigue Scale; ASPQ = Anxiety and Preoccupation About Sleep Questionnaire; A-SL = Actigraphy average sleep length in minutes; A-RSL = Actigraphy average time in restful sleep in minutes; SR-SL = Self report sleep length average in minutes.

Table 2

Means and Standard Deviations for the Control Group

Variable	N	<u>P-I</u>			<u>P-II</u>			<u>P-III</u>		
		M	SD	α	M	SD	α	M	SD	α
PSQI	48	5.98	1.91	.72	-	-	-	5.65	2.73	.81
ISI	49	9.14	5.32	.86	-	-	-	8.35	5.07	.85
SBS	49	12.84	2.81	.79	11.73	4.11	.79	11.31	4.76	.86
SHI	49	28.29	7.62	.76	-	-	-	28	8.93	.83
CFS	49	14.47	6.47	.89	-	-	-	13.69	6.70	.93
ASPQ	48	22.02	9.72	.95	-	-	-	21.65	9.49	.94
A-SL	39	464.80	45.58	-	-	-	-	469.01	57.82	-
A-RSL	39	233.44	55.03	-	-	-	-	240.05	52.65	-
SR-SL	44	455.75	52.04	-	-	-	-	462.27	64.38	-

Note: Means and standard deviations have been converted into mean item scores on the scales. These mean item raw scores were used to calculate the alpha coefficients, as well as the other analyses in this study. PSQI = Pittsburgh Sleep Quality Index; ISI = Insomnia Severity Index; SBS = Sleep Beliefs Scale; SHI = Sleep Hygiene Index; CFS = Chalder Fatigue Scale; ASPQ = Anxiety and Preoccupation About Sleep Questionnaire; A-SL = Actigraphy average sleep length in minutes; A-RSL = Actigraphy average time in restful sleep in minutes; SR-SL = Self report sleep length average in minutes.

Table 3

Means and Standard Deviations for the Treatment Group

Variable	N	<u>P-I</u>			<u>P-II</u>			<u>P-III</u>		
		M	SD	α	M	SD	α	M	SD	α
PSQI	45	6.51	2.74	.70	-	-	-	5.49	2.88	.70
ISI	46	8.71	4.58	.82	-	-	-	7.5	4.39	.82
SBS	46	11.78	3.62	.74	17.17	3.31	.84	16.5	4.02	.88
SHI	46	27.53	6.30	.70	-	-	-	28.24	6.88	.76
CFS	46	15.07	4.58	.78	-	-	-	13.59	5.64	.91
ASPQ	46	20.15	8.53	.94	-	-	-	20.73	8.63	.94
A-SL	39	467.79	59.76	-	-	-	-	477.08	55.57	-
A-RSL	39	239.45	53.50	-	-	-	-	248.12	51.29	-
SR-SL	42	455.44	63.77	-	-	-	-	465.74	56.43	-

Note: Means and standard deviations have been converted into mean item scores on the scales. These mean item raw scores were used to calculate the alpha coefficients, as well as the other analyses in this study. PSQI = Pittsburgh Sleep Quality Index; ISI = Insomnia Severity Index; SBS = Sleep Beliefs Scale; SHI = Sleep Hygiene Index; CFS = Chalder Fatigue Scale; ASPQ = Anxiety and Preoccupation About Sleep Questionnaire; A-SL = Actigraphy average sleep length in minutes; A-RSL = Actigraphy average time in restful sleep in minutes; SR-SL = Self report sleep length average in minutes.

The current sample was compared to normative samples using one-sample t-tests. The results of the one-sample t-test indicated that scores on the SHI for the current sample ($M = 27.93$) is significantly lower than mean for the sample ($M = 30.39$) that Ozdemir, Boysan, Slevi, Yldirim, & Yilmaz (2015) found in their sample, $t(1, 93) = -3.42, p < .01$. With respect to the

SBS, a one sample t-test also revealed the current sample scores ($M = 12.29$) are significantly lower than the standardization sample ($M = 13.05$; Adan et al., 2006), $t(1, 88) = -2.18, p < .05$. The current sample mean on the ASPQ ($M = 21.13$) was significantly higher than the sample of “poor sleepers” found in Jansson- Fröjmark et al.’s (2011) sample ($M = 17.4$), $t(1,93) = 3.94, p < .01$. The current sample means on the CFS ($M = 14.76$) did not significantly differ from the means of Celia and Chalder’s (2010) standardized sample ($M = 14.2$), $t(1, 94) = .97$. The current sample means on the ISI ($M = 8.94$) did not significantly differ from the means of Gellis, Park, Stotsky, and Taylor’s (2014) standardized sample ($M = 8.67$), $t(1, 94) = .53$. The current sample means of self-reported sleep length ($M = 456.09$) did not significantly differ from the means of Taylor, Bramoweth, et al.’s (2013) standardized sample ($M = 449.6$), $t(1, 82) = 2.65$. The current sample means of actigraphic sleep length ($M = 465.55$) did not significantly differ from the means of Carney, Lajos, and Water’s (2004) standardized sample ($M = 466.8$), $t(1, 76) = -.21$. The results of the one sample t-test also revealed that the sample mean on the PSQI for the current sample mean ($M = 6.25$) was not significantly different than the sample means of college students found in Calvert’s (2012) study ($M = 6.3$), $t(1, 88) = -.21$.

Correlations Between Variables

Table 4 provides a correlations matrix of all study variable. As expected, several of the variables were correlated with one another. The PSQI at P-I was negatively correlated with the SHI at P-I ($r = -.41, p < .01$) and P-III ($r = -.23, p < .05$) and was positively correlated with the PSQI at P-III ($r = .42, p < .01$), ISI at P-I ($r = .57, p < .01$) and P-III ($r = .32, p < .01$). Both the CFS ($r = .42, p < .01$) and the ASPQ ($r = .23, p < .05$) at P-I, but not P-III. Additionally, the PSQI at P-III was negatively correlated with the SHI at P-I ($r = -.23, p < .01$) and

P-III ($r = -.27, p < .05$), self-report sleep length at P-III ($r = -.25, p < .05$), and objective sleep length at P-I ($r = -.29, p < .05$) and P-III ($r = -.26, p < .05$). The PSQI at P-III was positively correlated with the ISI at P-I ($r = .46, p < .01$) and P-III ($r = .69, p < .01$), CFS at P-I ($r = .39, p < .01$) and P-III ($r = .46, p < .01$), and ASPQ at P-I ($r = .33, p < .01$) and P-III ($r = .50, p < .01$).

The ISI at P-I was negatively correlated with the SHI at P-I ($r = -.37, p < .01$) and P-III ($r = -.28, p < .05$) and was positively correlated with the ISI at P-III ($r = .62, p < .01$), CFS at P-I ($r = .48, p < .01$) and P-III ($r = .38, p < .01$), and ASPQ at P-I ($r = .64, p < .01$) and P-III ($r = .49, p < .01$). The ISI at P-III was negatively correlated with the CFS at P-I ($r = .38, p < .01$) and P-III ($r = .57, p < .01$), ASPQ at P-I ($r = .51, p < .01$) and P-III ($r = .65, p < .01$), self-report sleep length at P-III ($r = -.32, p < .01$), objective sleep length at P-I ($r = -.25, p < .05$) and P-III ($r = -.36, p < .01$), and objective restful sleep length at P-I ($r = -.24, p < .05$) and P-III ($r = -.26, p < .05$).

The SBS at P-I was positively correlated with the SBS at both P-II ($r = .42, p < .01$) and P-III ($r = .43, p < .01$). The SBS at P-II was positively correlated with the SBS at P-III ($r = .89, p < .01$) and objective sleep length at P-I ($r = .23, p < .05$).

The SHI at P-I was positively correlated with the SHI at P-III ($r = .78, p < .01$) and was negatively correlated with the CFS at P-I ($r = -.41, p < .01$) and ASPQ at P-I ($r = -.35, p < .01$) and P-III ($r = -.21, p < .05$). The SHI at P-III was negatively correlated with the CFS at P-I ($r = -.37, p < .01$) and P-III ($r = -.32, p < .01$) and the ASPQ at P-I ($r = -.28, p < .01$) and P-III ($r = -.26, p < .01$).

The CFS at P-I was positively correlated with the CFS at P-III ($r = .56, p < .01$) and ASPQ at P-I ($r = .38, p < .01$) and P-III ($r = .33, p < .01$). The CFS at P-III was negatively

correlated with self-report sleep length at P-III ($r = -.23, p < .05$), objective sleep length at P-III ($r = -.27, p < .05$), and objective restful sleep length at P-III ($r = -.26, p < .05$). The CFS at P-III was positively correlated with the ASPQ at P-I ($r = .38, p < .01$) and P-III ($r = .59, p < .01$).

The ASPQ at P-I was positively correlated with the ASPQ at P-III ($r = .70, p < .01$) negatively correlated with self-report sleep length at P-III ($r = -.25, p < .05$). The ASPQ at P-III was negatively correlated with self-report sleep length at P-III ($r = -.34, p < .05$) and objective sleep length at P-I ($r = -.27, p < .05$) and P-III ($r = -.28, p < .05$).

Many of the sleep length variables had significant correlation. Self-report sleep length at P-I was positively correlated with self-report sleep length at P-III ($r = .60, p < .01$) and objective sleep length at P-I ($r = .71, p < .01$) and P-III ($r = .37, p < .01$). Self-report sleep length at P-III was positively correlated with objective sleep length at P-I ($r = .50, p < .01$) and P-III ($r = .78, p < .01$) and objective restful sleep length at P-I ($r = .38, p < .01$) and P-III ($r = .39, p < .01$). Objective sleep length at P-I was positively correlated with objective sleep length at P-III ($r = .55, p < .01$) and objective restful sleep length at P-I ($r = .41, p < .01$) and P-III ($r = .31, p < .01$). Objective sleep length at P-I was positively correlated with objective restful sleep length at P-I ($r = .37, p < .01$) and P-III ($r = .55, p < .01$). Objective restful sleep length at P-I was positively correlated with objective restful sleep length at P-III ($r = .83, p < .01$).

Table 4

Correlations Among Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. PSQI(1)	-																		
2. PSQI (2)	.42**	-																	
3. ISI (1)	.57**	.46**	-																
4. ISI (2)	.32**	.69**	.62**	-															
5. SBS (1)	.10	.10	.04	.70	-														
6. SBS (2)	.06	.03	-.11	-.09	.42**	-													
7. SBS (3)	.09	.07	-.10	-.07	.43**	.89**	-												
8. SHI (1)	-.41**	-.23**	-.37**	-.21*	.06	.08	.06	-											
9. SHI (2)	-.23*	-.27**	-.28**	-.18	.03	.02	.01	.78**	-										
10. CFS (1)	.42**	.39**	.48**	.38**	.01	.09	.09	-.41**	-.37**	-									
11. CFS (2)	.09	.46**	.38**	.57**	.13	.08	.08	-.15	-.32**	.56**	-								
12. ASPQ (1)	.23*	.33**	.64**	.51**	-.02	-.09	.00	-.35**	-.28**	.38**	.38**	-							
13. ASPQ (2)	.07	.50**	.49**	.65**	.00	-.05	.04	-.21*	-.26*	.33**	.59**	.70**	-						
14. SRSL (1)	-.04	-.19	-.30	-.11	.09	.09	-.02	.16	.07	-.15	-.08	-.20	-.19	-					
15. SRSL (2)	.00	-.25*	-.01	-.32**	.04	-.03	-.12	.07	.09	-.11	-.23*	-.25*	-.34*	.60**	-				
16. OSL (1)	-.04	-.29*	-.22	-.25*	.12	.23*	.17	.06	.01	-.11	-.15	-.15	-.27*	.71**	.50**	-			
17. OSL (2)	.08	-.26*	-.01	-.36**	.11	.14	.11	-.13	-.08	-.10	-.27*	-.10	-.28*	.37**	.78**	.55**	-		
18. ROSL (1)	-.10	-.18	-.20	-.24*	.08	.16	.13	-.07	-.06	-.23	-.20	-.13	-.16	.21	.38**	.41**	.37**	-	
19. ROSL (2)	.09	-.17	-.09	-.26*	.10	.16	.10	-.02	-.07	-.16	-.26*	-.06	-.18	.14	.39**	.31**	.55**	.83**	-

Note. * $p < .05$; ** $p < .01$. $N = 95$. PSQI = Pittsburgh Sleep Quality Index; ISI = Insomnia Severity Index; SBS = Sleep Beliefs Scale; SHI = Sleep Hygiene Index; CFS = Chalder Fatigue Scale; ASPQ = Anxiety and Preoccupation About Sleep Questionnaire; SRSL = Self report sleep length

Data Analysis

The final sample consisted of 95 college students. All participants attended all three time points (P-I, P-II, P-III) and completed 80% or more of the study data at all three time points. Preliminary analyses were conducted prior to hypothesis testing to assess the presence of outliers, missing data, and normality. Additionally, group homogeneity at P-I of the study were examined through Levine's test of homogeneity. The groups did not significantly differ in terms of age, $F(1, 93) = 1.99$, sex, $F(1, 93) = 2.34$, race, $F(1, 91) = 1.37$, living situation, $F(1, 93) = 1.86$, class, $F(1, 93) = .48$, or GPA, $F(1, 88) = .46$.

A one-way ANOVA was also conducted to examine if the groups differed significantly on any of the variables at P-I. Results indicated that the group variances were not significantly different on any of the variables at P-I: ISI Total, $F(1, 93) = .17$; PSQI Total, $F(1, 87) = 1.13$; SHI Total, $F(1, 92) = .28$; ASPQ Total, $F(1, 92) = .97$; SBS Total, $F(1, 87) = 2.33$; CFS total, $F(1, 93) = .27$; self-report sleep length total, $F(1, 82) = .01$; objective amount of time in restful sleep total, $F(1, 76) = .24$, and objective sleep length total, $F(1, 76) = .06$.

Hypothesis 1A:

To test whether the intervention impacted sleep quality over time, a mixed between-within subjects analysis of variance (ANOVA) was conducted. Hypothesis 1A stated that individuals in the treatment group would have significantly higher sleep quality compared to participants in the control group at P-III. This analysis had two independent factors: a within subjects factor (time), with two levels (P-I, P-III), and a

between-subjects factor (group), with two levels (control, treatment). The dependent variable was sleep quality as measured by participants' PSQI total score.

Prior to conducting the statistical analysis, assumptions of the mixed between-within subjects ANOVA were examined. Analysis indicated the absence of outliers and the assumption of normality are met as evaluated through visual inspection of histograms, Q-Q plots, skewness, and kurtosis values. Levene's test indicated that the homogeneity of variance assumption was violated at P-I, $F(1,87) = 6.08, p = 0.02$, but not at P-III, $F(1,87) = 1.87, p = .18$. Box's Test of Equality of Covariance Matrices was also violated, $F(3, 1385365) = 9.18, p < .001$. However, ANOVA is reasonably robust to a violation of the assumption of homogeneity of variance when groups are of similar size. Thus, the ANOVA can still be conducted (Tabachnick & Fidel, 2013).

The means and standard deviations of the PSQI at each level of the independent factors are presented in Table 5. Results showed there was no significant interaction between the time (P-I and P-III) and group (treatment or control), Wilk's Lambda = .99, $F(1, 87) = .74, p = 0.39$, partial $\eta^2 = .01$. There was a significant main effect for time, Wilk's Lambda = .92, $F(1, 87) = 7.11, p = 0.01$, partial $\eta^2 = .08$, with both groups showing a decrease in PSQI scores from P-I to P-III (See Table 5). The main effect comparing the groups was not significant, $F(1, 87) = .39, p = 0.53$, partial $\eta^2 = .004$, which suggests the intervention was not effective as it relates to sleep quality. Hypothesis 1A was not supported.

Table 5

PSQI total scores for groups at P-I and P-III

Group	<i>n</i>	P-I		P-III	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Treatment	45	6.51	2.74	5.49	2.88
Control	44	5.98	1.91	5.45	2.51

Hypothesis 1B:

To test whether the intervention impacted sleep length over time, a multivariate analysis of covariance (MANCOVA) was conducted. Hypothesis 1B stated that individuals in the treatment group would have significantly higher sleep length compared to participants in the control group at P-III after controlling for P-I sleep length. This analysis had one independent factor (group), with two levels (control, treatment), and two dependent factors: Objective sleep length, as measured by the average from actigraphy data, and subjective sleep length, as measured by the average sleep length from sleep log data, at phase III. The average objective and subjective sleep length at P-I were covariates.

Preliminary checks were conducted to ensure that there were no violations of the assumptions of normality, linearity, homogeneity of variance, homogeneity of regression slopes, and reliable measurement of the covariate. The absence of outliers assumption was appropriately met as indicated by Mahal's Distance below 13.82. Linearity was assessed through visual inspection of matrix variables scatterplots. Homogeneity of variance was satisfied for both objective sleep length, $F(1, 65) = .24, p < .63$, and

subjective sleep length, $F(1, 65) = .05, p < .82$. Homogeneity of variance-covariance matrices was also met as evidenced by Box's Test of Equality of Covariance Matrices, $F(3, 1038839) = .17, p < .92$.

Results of the MANCOVA can be found in Table 6. After adjusting for P-I sleep length, there was no significant difference between the treatment and control groups average sleep length at P-III, $F(2, 62) = .01, p = .99$ (See Table 6). Hypothesis 1B is not supported.

Table 6

Results of the MANCOVA for Hypothesis 1B

	<i>M</i>	<i>df</i>	<i>F</i>	<i>partial η^2</i>	<i>p</i>
Group		2	.01	.00	.99
Actigraphy (P-I)		2	20.55	.40	.00
Treatment	467.79				
Control	463.25				
Self-Report (P-I)		2	13.49	.30	.00
Treatment	455.44				
Control	456.66				

Note: N = 67

Hypothesis 1C:

To test whether the intervention impacted time spent in restful sleep, a mixed between-within subjects analysis of variance (ANOVA) was conducted. Hypothesis 1C stated that individuals in the treatment group would have significantly greater time spent in restful sleep compared to participants in the control group at P-III. This analysis had two independent factors: a within subjects factor (time), with two levels (P-I, P-III), and a between-subjects factor (group), with two levels (control, treatment). The dependent variable is average length of time spent in restful sleep as measured by actigraphy.

Prior to conducting the statistical analysis, assumptions of the mixed between-within subjects ANOVA were examined. Analysis indicated the absence of outliers and the assumption of normality are met as evaluated through visual inspection of histograms and Q-Q plot as well as skewness and kurtosis values. Levene's test indicated that the homogeneity of variance assumption was not violated at P1, $F(1,76) = .44, p = .51$ or P3, $F(1,76) = .09, p = .76$. Box's Test of Equality of Covariance Matrices was not violated, $F(3, 1039680) = .01, p = .99$.

The means and standard deviations of the amount of time spent in restful sleep at each level of the between-subjects factor are presented in Table 7. Results showed there was no significant interaction between the time (P-I and P-III) and group (treatment or control), Wilk's Lambda = 1.0, $F(1, 76) = .09, p = 0.77$, partial $\eta^2 = .001$. There was a significant main effect for time, Wilk's Lambda = .94, $F(1, 76) = 4.66, p = 0.03$, partial $\eta^2 = .06$, with both groups showing an increase in time spent in restful sleep from P1 to

P3 (See Table 7). The main effect comparing the groups was not significant, $F(1, 76) = .37, p = 0.54$, partial $\eta^2 = .005$, which suggests the intervention was not effective in increasing time spent in restful sleep. Hypothesis 1C was not supported.

Table 7

Average Length of Time in Minutes Spent in Restful Sleep for Groups at P-I and P-III

Group	<i>n</i>	P-I		P-III	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Treatment	39	239.45	53.50	248.12	51.29
Control	39	233.44	55.03	240.05	52.65

Hypothesis 2:

Hypothesis 2 stated that individuals in the treatment group would not have significant differences between objective actigraphy, as measured by the Misfit Flash, and self-report data of sleep length, measured by the sleep log. This hypothesis was tested using correlational analysis, with the expectation that actigraphy and self-report data would be highly correlated. Preliminary analysis were performed to ensure assumptions of normality, linearity, and homoscedasticity were not violated. There was a strong, positive correlation between the variables, $r = .76, p < .001$, indicating that greater self-report sleep length was associated with greater objective sleep length. Hypothesis 2 was supported, indicating that self-report and objective sleep length data are sampling a common underlying construct.

Hypothesis 3A:

Hypothesis 3A stated that individuals in the treatment group would have significantly improved sleep hygiene awareness between P-I and P-II, that would be maintained at P-III. This hypothesis was tested using a two-way, repeated measures mixed ANOVA. The analysis included two independent factors: one within subject factor (time) had three levels (P-I, P-II, P-III) . The dependent variable is sleep hygiene awareness, as measured by the total score on the SBS.

The assumptions of the a two-way, repeated measures mixed ANOVA were examined. Analysis indicated the absence of outliers and the assumption of normality are met as evaluated through visual inspection of histograms and Q-Q plot, Shapiro-Wilks test, and skewness and kurtosis values. Levene's test indicated that the homogeneity of variance assumption was violated at P-I, $F(1,86) = 4.04, p = .05$, but not at P-II, $F(1,86) = .13, p = .72$, or P-III, $F(1, 86) = .33, p = .57$. Box's Test of Equality of Covariance Matrices also indicated that the assumption is met, $F(3, 52367) = 3.03, p = .006$. In order to test the sphericity assumption, Mauchly's test of sphericity was used. The results of this test indicated that the sphericity assumption was violated, $\chi^2(2) = .85, p = .001$. Thus, the results of the Greenhouse-Geisser will be reported as this statistic correct the degrees of freedom when the assumption of sphericity is violated.

The means and standard deviations of the SBS at each level of the between-subjects factors are presented in Table 8. The results of the two-way repeated measures mixed ANOVA indicated there was a significant interaction between the intervention and sleep hygiene awareness, $F(2, 149.43) = 55.14, p < .001, \eta^2 = .39$. There was a main effect for time, $F(2, 149.43) = 38.97, p < .001$, partial $\eta^2 = .31$, with the treatment group

showing significant increase in SBS scores between P-I and P-II, and results maintained at P-III, whereas the control group scores remained relatively unchanged across all three time points (See Table 8). The main effect comparing the two groups was also significant, $F(1, 86) = 14.67, p < .001, \eta^2 = .15$, with the treatment group showing significant increase in sleep hygiene awareness, suggesting that the intervention was effective at increasing sleep hygiene awareness. These results support Hypothesis 3A.

Table 8

Means and Standard Deviation for the SBS at Each Phase

	Treatment		Control	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
P-I	11.78	3.62	12.95	2.74
P-II	17.17	3.32	12.71	3.06
P-III	16.50	4.02	12.19	4.07

Hypothesis 3B:

Hypothesis 3B stated that individuals in the treatment group would have significantly improved sleep hygiene practices compared to participants in the control group. To test whether the intervention impacted sleep hygiene practices over time, a mixed between-within subjects analysis of variance (ANOVA) was conducted. This analysis had two independent variables: a within subjects factor (time), with two levels (P-I, P-III), and a between-subjects factor (group), with two levels (control, treatment).

The dependent variable was sleep hygiene practices as measured by participants' SHI total scores.

Prior to conducting the statistical analysis, assumptions of the mixed between-within subjects ANOVA were examined. Analysis indicated the absence of outliers and the assumption of normality were met as evaluated through visual inspection of histograms and Q-Q plot as well as skewness and kurtosis values. Levene's test indicated that the homogeneity of variance assumption was not violated at P-I, $F(1,92) = 1.64, p = 0.20$ or P-III, $F(1,92) = 1.57, p = .21$. Box's Test of Equality of Covariance Matrices was not violated, $F(3, 1998513) = 3.01, p = .40$.

The means and standard deviations of the SHI at each level of the independent variables are presented in Table 9. Results showed there was no significant interaction between the time (P-I, P-III) and group (treatment or control), Wilk's Lambda = .99, $F(1, 92) = .84, p = 0.36$, partial $\eta^2 = .01$. There was no significant main effect for time, Wilk's Lambda = 1.0, $F(1, 92) = .14, p = 0.71$, partial $\eta^2 = .001$, or group, $F(1, 92) = .04, p = .85$, partial $\eta^2 = .00$, which suggests the intervention was not effective at increasing sleep hygiene practices. Hypothesis 3B was not supported.

Table 9

SHI Total Scores for Groups at P-I and P-III

Group	<i>n</i>	P-I		P-III	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Treatment	45	27.53	6.30	28.20	6.95
Control	49	28.29	7.62	28.00	8.93

Hypothesis 4A:

Hypothesis 4A stated that overall, individuals with lower levels of anxiety about sleep, as measured by the APSQ, would have significantly greater sleep quality, as measured by the PSQI, compared to participants with higher levels of anxiety about sleep. Specifically, it was expected that there would be a significant positive correlation between ASPQ and PSQI scores. Preliminary analysis were performed to ensure assumptions of normality, linearity, and homoscedasticity were not violated. The ASPQ failed the assumption of normality, thus a square root transformation was conducted to correct for the non-normal distribution (Field, 2009). The transformation did not correct the data sufficiently enough to meet the assumption of normality. As a result, a Spearman's rank-order correlation, which is a non-parametric test, was conducted to assess the relationship between sleep quality and anxiety about sleep.

Results of the Spearman's rank-order correlation showed a significant, moderate, positive correlation between sleep quality and anxiety about sleep, which was statistically significant ($r_s = .53, p < .001$). This indicates that as participants sleep quality increased, their anxiety about sleep also decreased and vice-versa. This supports Hypothesis 4A.

Hypothesis 4B:

Hypothesis 4B stated that overall, individuals with lower levels of anxiety about sleep, as measured by the APSQ, would have significantly greater sleep length, as measured by actigraphy data, compared to participants with higher levels of anxiety about sleep. This analysis was tested through a Spearman's rank-order correlation analysis with the expectation that there would be a significant negative correlation between ASPQ scores and subjective sleep length. Preliminary analysis were performed

to ensure assumptions of normality, linearity, and homoscedasticity were not violated. As mentioned above, the ASPQ failed the assumption of normality, thus a non-parametric test was conducted to assess the relationship between sleep length and anxiety about sleep. Results of the Spearman's rank-order correlation showed a significant, small, negative correlation between sleep length and anxiety about sleep ($r_s = -.29, p < .01$). This indicates that as participants anxiety about sleep decreased, their sleep length increased. Hypothesis 4B was supported.

Hypothesis 5:

Hypothesis 5 stated that individuals in the treatment group would have significantly lower fatigue than participants in the control group. This hypothesis was tested using a mixed between-within subjects ANOVA. This analysis had two independent variables: a within subjects factor (time), with two levels (P-I, P-III), and a between-subjects factor (group), with two levels (control, treatment). The dependent variable was fatigue as measured by scores on the CFS.

Prior to conducting the statistical analysis, assumptions of the mixed between-within subjects ANOVA were examined. Analysis indicated the absence of outliers and the assumption of normality are met as evaluated through visual inspection of histograms and Q-Q plot as well as skewness and kurtosis values. Levene's test indicated that the homogeneity of variance assumption was violated at P-I, $F(1,93) = 5.01, p = .03$, but was not violated at P-III, $F(1,93) = 1.00, p = .32$. Box's Test of Equality of Covariance Matrices was not violated, $F(3, 1790778) = .1.83, p = .14$. As previously noted, ANOVA is reasonably robust to a violation of the assumption of homogeneity of variance when

groups are of similar size. Thus, the ANOVA can still be conducted (Tabachnick and Fidell, 2007).

The means and standard deviations of the CFS at each level of the independent variables are presented in Table 10. Results showed there was no significant interaction between the time (P-I and P-III) and group (treatment or control), Wilk's Lambda = 1.0, $F(1, 93) = .38, p = 0.54$, partial $\eta^2 = .004$. There was a significant main effect for time, Wilk's Lambda = .96, $F(1, 93) = 3.92, p = 0.05$, partial $\eta^2 = .04$, with both groups showing a decrease in fatigue from P-I to P-III (See Table 10). The main effect comparing the groups was not significant, $F(1, 93) = .05, p = 0.82$, partial $\eta^2 = .001$, which suggests the intervention was not effective in decreasing fatigue. Hypothesis 5 was not supported.

Table 10

CFS Total Scores for Groups at P-I and P-III

Group	<i>n</i>	P-I		P-III	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Treatment	46	15.07	4.58	13.59	5.64
Control	49	14.47	6.46	13.69	6.70

Hypothesis 6:

Hypothesis 6 stated that individuals in the treatment group would have significantly lower rates of insomnia symptoms than participants in the control group. This hypothesis was tested using a mixed between-within subjects ANOVA. This

analysis had two independent variables: a within subjects factor (time), with two levels (P-I, P-III), and a between-subjects factor (group), with two levels (control, treatment). The dependent variable is insomnia as measured by participants ISI total score.

Prior to conducting the statistical analysis, assumptions of the mixed between-within subjects ANOVA were examined. Analysis indicated the absence of outliers and the assumption of normality was met as evaluated through visual inspection of histograms and Q-Q plot as well as skewness and kurtosis values. Levene's test indicated that the homogeneity of variance assumption was not violated at P-I, $F(1,93) = 1.72, p = 0.19$, or P-III, $F(1,93) = 1.82, p = .18$. Box's Test of Equality of Covariance Matrices was not violated, $F(3, 1790778) = .59, p = .62$.

The means and standard deviations of the ISI at each level of the independent variables are presented in Table 11. Results showed no significant interaction between the time (P-I and P-III) and group (treatment or control), Wilk's Lambda = .99, $F(1, 93) = .23, p = 0.63$, partial $\eta^2 = .002$. There was a significant main effect for time, Wilk's Lambda = .95, $F(1, 93) = 5.27, p = 0.02$, partial $\eta^2 = .05$, with both groups showing a decrease in ISI scores from P-I to P-III (See Table 11). The main effect comparing the groups was not significant, $F(1, 93) = .50, p = 0.48$, partial $\eta^2 = .005$, which suggests the intervention was not effective in changing insomnia symptoms. Hypothesis 6 was not supported.

Table 11

ISI Total Scores for Groups at P-I and P-III

Group	<i>n</i>	P-I		P-III	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Treatment	46	8.72	4.58	7.50	4.39
Control	49	9.14	5.32	8.35	5.07

Hypothesis 7:

Hypothesis 7 stated that an interaction existed between anxiety about sleep, as measured by the ASPQ, and sleep hygiene knowledge, as measured by the SBS, and sleep hygiene practices, as measured by the SHI. This hypothesis was tested using a moderation analysis. Specifically, a hierarchical regression analysis was conducted to determine (a) the amount of variance in sleep hygiene practices explained by sleep hygiene knowledge and anxiety about sleep; and (b) whether anxiety about sleep moderated the relationship between sleep hygiene awareness and sleep hygiene practices. Zero order correlations, means, and standard deviations of the overall scale scores can be found in Table 12. The predictor, independent, and moderator variables were standardized to reduce multicollinearity problems. The product of standardized sleep hygiene knowledge (SBS) and standardized anxiety about sleep (ASPQ) created the interaction variable.

Preliminary exploratory analysis indicated that there was no problem with multicollinearity, since the highest variance inflation factor was 1.03. Linearity was assessed visually via the scatterplot matrices and indicated that the linearity assumption

was met. Homoscedasticity was assessed visually through the scatterplot of predicted and residual scores. The scatterplot indicated that the assumption of homoscedasticity was also met. Normality was assessed through visual inspection of the Normal Probability Plot of the Regression of Standardized Residual and Scatterplot and indicated that the normality assumption was met. Problems with outliers were assessed through Cooks distance, Mahalanobis distance, and Centered Leverage Value. The maximum Cooks value was .71, which indicated no problem with outliers since it is below one. Mahalanobis distance and Centered Leverage Value were assessed for each participant and did not indicate a problem with outliers. Sleep hygiene knowledge was entered as step one; anxiety about sleep was entered as step two; the interaction between sleep hygiene knowledge and anxiety about sleep were entered as a block into step three.

Results of the regression analysis can be seen in Table 13. In the first step of the regression, sleep hygiene knowledge did not account for any of the variance in sleep hygiene practices, $F(1, 92) = .003, p < .96$. In step two, anxiety about sleep accounted for 6.9% of the variance in sleep hygiene practices, $F(2, 91) = 3.36, p = .04$. In step three, the interaction between sleep hygiene knowledge and anxiety about sleep only accounted for an additional .1% of the variance in presence of sleep hygiene practices over and above the variance accounted for by sleep hygiene knowledge and anxiety about sleep and was not significant, $\Delta R^2 = .001; \Delta F(3, 90) = 2.26, p = .09$. Hypothesis 7 is not supported.

Table 12

Zero Order Correlations, Means, and Standard Deviations among Overall Scale Scores for Hypothesis 7

	1	2	3	<i>M</i>	<i>SD</i>
1. ASPQ	-	.04	-.26*	21.20	9.05
2. SBS		-	.01	13.85	5.11
3. SHI			-	28.12	7.96

Note. $N = 94$, * $p < .05$

Table 13

Hierarchical Multiple Regression: Anxiety about sleep as a moderator of the sleep knowledge-sleep hygiene practices relationship

Variable	B	SE	β	t	p	LCI 95%	UCI 95%	R ²	F	p	ΔR^2	ΔF	Δp
Step 1								.000	.003	.96	-	-	-
SBS	.01	.16	-.26	.06	.96	-.32	.33						
Step 2								.069	3.35	.04	.069	6.71	.01
SBS	.02	.16	-.16	.02	.88	-.29	.34						
	-.23	.09	-.26	-2.60	.01	-.41	-.05						
ASPQ													
Step 3								.070	2.26	.09	.001	.13	.72
SBS	.03	.16	.02	.21	.83	-.29	.36						
	-.23	.09	-.26	-2.59	.01	-.41	-.05						
ASPQ													
Int.	.01	.02	.04	.36	.72	-.03	.04						

Note. N = 94; LCI 95% - Lower confidence interval 95%; UCI 95% = Upper confidence interval 95%; Int. = ASPQ X SBS interaction

Hypothesis 8:

Hypothesis 8 stated that an interaction existed between beliefs about sleep, as measured by the SBS, and sleep length, as measured by participants' self-report sleep logs, and sleep quality, as measured by the PSQI. This hypothesis was tested using a moderation analysis. Specifically, a hierarchical regression analysis was conducted to determine (a) the amount of variance in sleep quality explained by sleep length and sleep beliefs; and (b) whether sleep beliefs moderated the relationship between sleep hygiene practices and sleep quality. Zero order correlations, means, and standard deviations of the overall scale scores can be found in Table 14. The predictor, independent, and moderator variables were standardized to reduce multicollinearity problems. The product of standardized sleep length and standardized sleep beliefs (SBS) was the interaction variable.

Preliminary exploratory analysis indicated that there was no problem with multicollinearity, since the highest variance inflation factor was 1.24. Linearity was assessed visually via the scatterplot matrices and indicated that the linearity assumption was met. Homoscedasticity was assessed visually through the scatterplot of predicted and residual scores. The scatterplot indicated that the assumption of homoscedasticity was also met. Normality was assessed through visual inspection of the Normal Probability Plot of the Regression of Standardized Residuals and Scatterplot and indicated that the normality assumption was met. Problems with outliers were assessed through Cooks distance, Mahalanobis distance, and Centered Leverage Value. The maximum Cooks value was .79, which indicated no problem with outliers since it is below one. Mahalanobis distance and Centered Leverage Value were assessed for each

participant and did not indicate a problem with outliers. Sleep beliefs were entered as step one; sleep length was entered as step two; the interaction between sleep beliefs and sleep length were entered as a block into step three.

Results of the regression analysis can be seen in Table 15. In the first step of the regression, sleep length accounted for 5.9% of the variance in sleep quality, $F(1, 81) = 5.10, p = .03$. In the second step of the regression, sleep beliefs did not for additional variance in sleep quality, $F(2, 80) = 2.59, p = .08$. In step three, the interaction between sleep beliefs and sleep length did not account for any additional variance in sleep quality and was not significant, $\Delta R^2 = .000; \Delta F(3, 79) = 1.71, p = .17$. Hypothesis 8 is not supported.

Table 14

Zero Order Correlations, Means, and Standard Deviations among Overall Scale Scores for Hypothesis 8

	<i>n</i>	1	2	3	<i>M</i>	<i>SD</i>
1. SRSL	86	-	-.11	-.23*	465.3	59.35
2. SBS	94		-	.07	13.85	5.11
3. PSQI	93			-	5.56	2.79

Note. * $p < .05$; SRSL = Self-report sleep data

Table 15

Hierarchical Multiple Regression: Sleep beliefs as a moderator of the sleep length-sleep quality relationship

Variable	B	SE	β	t	p	LCI	UCI	R ²	F	p	ΔR^2	ΔF	Δp
le						95%	95%						
Step 1								.059	5.10	.03	-	-	-
SRSL													
Step 2	-.01	.01	-.24	-2.26	.03	-.02	-.001	.061	2.59	.08	.002	.142	-.71
SRSL													
SBS	-.01	.01	-.24	-2.17	.03	-.02	-.001						
Step 3								.061	1.17	.17	.000	.006	.94
SRSL													
SBS	.02	.06	.04	.38	.71	-.10	.15						
Int.	-.01	.01	-.24	-2.11	.04	-.02	-.001						
SBS	.03	.07	.05	.37	.71	-.11	.16						
Int.	.00	.00	-.01	-.08	.94	-.002	.002						

Note. N = 94; LCI 95% - Lower confidence interval 95%; UCI 95% = Upper confidence interval 95%; Int. = SRSL X SBS interaction; SRSL = Self-report sleep data

CHAPTER FOUR

DISCUSSION

This section provides a general overview of results followed by discussion of each hypothesis. Additionally, an explanation of limitations, implications, and suggestions for future research are included.

Results Overview

The purpose of this study was to examine the efficacy of a psychoeducational sleep intervention for college students through self-report and physiological measures. Additionally, other factors were examined that may serve as barriers to implementation of psychoeducational information. The main variables were sleep length, sleep quality, sleep hygiene knowledge, and sleep hygiene behaviors. In this sample of college students, there was no significant difference in average sleep length compared to Carney et al. (2004) or average sleep quality compared to Taylor, Bramoweth, et al.'s (2013) samples. The average score on the SBS among this sample was significantly lower than that found by Adan et al. (2006), indicating poorer sleep hygiene knowledge in this sample. Additionally, the sample had significantly lower scores on the Sleep Hygiene Index (Mastin et al., 2006) compared to Ozdemir's (2015) sample, indicating poorer

hygiene practices. Additionally, several of the study variables were significantly correlated with one another (see Table 4).

While the SPEAK intervention significantly improved sleep hygiene knowledge, participants did not apply this knowledge to their sleep-related behaviors and practices, and anxiety about sleep was not found to moderate the relationship between sleep beliefs and sleep hygiene practices. Results showed that overall the SPEAK intervention did not increase sleep quality, total sleep length, or time spent in restful sleep over the duration of the study, and the relationship between sleep length and sleep quality is not moderated by beliefs about sleep. Additionally, the SPEAK intervention did not significantly impact self-reported fatigue or insomnia symptoms. Results did support that self-report and actigraphic sleep length were comparable, indicating that individuals self-report of sleep data was accurate.

Hypothesis 1A, 1B, and 1C

Hypothesis 1A states that there would be a significant difference between average sleep quality in the groups at P-III. Specifically, it was expected that participants in the treatment group would have significantly greater sleep quality than participants in the control group. It was hypothesized that individuals that received the SPEAK intervention would report higher sleep quality than the control group. The results of the ANOVA did not support this hypothesis. The results indicated that there was no statistically significant interaction between participant group and time, nor did group have a significant main effect on sleep quality. However, results did indicate a significant main effect for time on sleep quality. The intervention did not work to increase sleep quality. While many studies have shown support for psychological intervention utilizing sleep hygiene and stimulus

control (Brown et al., 2006; Tan et al, 2012), others have found these intervention techniques to lack empirical support (Calvert, 2012; National Sleep Foundation, 2006a).

There are several possible explanations for these results. For example, it is possible that the two-week post-intervention period was not an adequate length of time to allow participants to make significant changes and implement sleep hygiene practices to impact sleep quality. It is likely that participants would need an extended length of time to implement changes in their routines and beliefs that may not be practical in a two-week period. For example, establishing a consistent sleep-wake schedule or build an association between their bed and sleep would likely take several weeks for their mind and body to conform to a new routine. Collecting sleep quality data for a longer post-intervention period might have yielded more promising results, as it would allow time to initiate behavioral changes and overcome barriers to improving the quality of their sleep. Additionally, when considering that there was no significant changes in sleep hygiene practices (Hypothesis 4B), it is reasonable to assume there would not be changes in participants sleep quality, as participants would be likely to see improvements in sleep quality only after altering behaviors that may negatively impact sleep. College students are also unique in that there are limitations to the factors that they may have control over. For example, work and school schedules may be a barrier for consistent sleep-wake times, and living in a dorm or with roommates may diminish or eliminate participants' control over factors such as room temperature or background noise. Also of note, participants PSQI scores indicated that they were only slightly above the cutoff for identifying poor sleepers, indicating that sleep quality in college students may not be as problematic as cited in past literature (Buboltz et al., 2001). Students participating in this

study may have also been externally motivated to participate as they were provided with extra credit in classes as well as the opportunity to be entered into a raffle, thus they may have completed the necessary components without being motivated to change their perceptions or behaviors.

Hypothesis 1B states that that there would be a significant difference in sleep length between the groups at P-III. Specifically, it was predicted that participants in the treatment group would have significantly greater sleep length than participants in the control group. Results of MANCOVA did not support this hypothesis. They indicated that there was no statistically significant difference between the groups at P-III.

There are many possible reasons for these results. First, although past research indicated insufficient sleep as a prominent issue in college students (Bonnet & Arand, 2012; Carney et al., 2006; Lund et al., 2010), the present participants reported an average of 7.76 hours of sleep per night at baseline, which aligns with the National Sleep Foundation's (2015) recommendation of seven to nine hours of sleep per night for adults between the age of 18 and 25. Thus, one possible explanation for the insignificant change in sleep length is that students are already getting an adequate amount of sleep. Students sleeping within the recommended range are less likely to identify a need to alter their sleep patterns and therefore were less motivated to implement information provided in the intervention. Other possible explanations include the short timeframe in which the follow-up was conducted or failure to implement sleep hygiene practices due to lack of control over external factors as mentioned above.

Hypothesis 1C stated that that there would be a significant difference in time spent in restful sleep between the groups at P-III. Specifically, it was predicted that

participants in the treatment group would have significantly greater amount of time in restful sleep, as measured by actigraphy, than the control group. This hypothesis was not supported; the groups did not differ at P-III. Other possible reasons include insufficient time to implement sleep hygiene practices, limited control over various factors impacting sleep, and possible lack of motivation to implement changes since participants reported sleep quality at baseline was only slightly above the cutoff for identification of poor sleepers, and participants reported sleep length was in the recommended length. It is not surprising that participant's length of time spent in restful sleep was not significantly different as they did not have significant changes in their sleep length or sleep quality. Additionally, participants spent an average of 3.94 hours in restful sleep each night, which accounts for approximately 51% of their total sleep time.

Hypothesis 2

Hypothesis 2 stated that participants would not have significant differences between their subjective and objective measures of sleep length as measured by actigraphy and sleep logs. This hypothesis was confirmed and is consistent with past research (Thun et al., 2012).

These results suggest that participant's perception and tracking of sleep times and duration is consistent with that obtained with objective sleep data. Researchers commonly utilize self-report data in studies, including those focusing on sleep. These results support that self-report data is a reliable and valid means of collecting data in college students. While the use of actigraphy in research can be very helpful, it is also more time consuming, costly, and is burdened by technological difficulties that are not present when utilizing self-report data.

Hypothesis 3A and 3B

Hypothesis 3A stated that there would be a significant difference in sleep hygiene awareness between the groups and phase of the study. Specifically, it was predicted that participants in the treatment group would show significant improvement in their sleep hygiene awareness between P-I and P-II and this would be maintained at P-III compared to the control group. This hypothesis was supported.

These results are consistent with past research that indicated that college students' sleep hygiene knowledge and perceptions regarding sleep were generally low (Bosie et al., 2012), but that providing psychoeducation about sleep hygiene allowed for dispersion of information and that knowledge was retained at follow-up (Hauri, 1993). The results indicate that participants in the treatment group were engaged and attended to the content of the intervention, as evidenced by a 45% increase in the SBS scores at P-II (11.78 versus 17.17). This confirms that the 45-minute intervention is sufficient to teach participants about healthy sleep hygiene practices and beliefs. Additionally, participants in the treatment group retained the information taught for two-weeks after the intervention, indicating integration of information into memory.

Hypothesis 3B states that there would be a significant difference in groups sleep hygiene practices. Specifically, it was hypothesized that participants in the treatment group would show significant improvement in their sleep hygiene practices between P-I and P-III. The results do not support this hypothesis. While participants demonstrated improved and sustained sleep hygiene knowledge, they did not apply this information to alter their sleep hygiene practices.

There are several possible explanations for these results. One possible explanation, as mentioned above, is that overall participants reported sleeping within the recommended range at baseline, which is likely to decrease motivation or a perceived need to alter their behaviors. Compared to Ozdemir et al.'s (2015) sample, the current sample had significantly lower sleep hygiene practices at baseline, which may indicate student's perceptions of sleep behaviors are not seen as problematic or in need of alteration. College students may also struggle to implement sleep hygiene behaviors due to the variability in their schedules related to employment, class times, and extracurricular activities. In fact, research finds that variations in sleep schedules as one of the most problematic behaviors impacting sleep in college students (Trockel et al., 2000). College students report increased rates of anxiety as they face new challenges associated with transitioning to college (Fuligni & Hardway, 2006), which may reduce their ability to implement additional behavioral changes. If students are attempting to adapt to a new environment and stressors, they may be disinclined to attempt to alter their sleep patterns in the midst of many other changes occurring.

Although many studies support the use of sleep hygiene practices to increase behaviors promoting sleep (Hauri, 1993; Morin et al., 1994; Murtagh & Greenwood, 1995), other studies found that sleep hygiene knowledge does not necessarily translate into sleep hygiene practices (Holbrook et al., 1997; Morgenthaler et al., 2007). The participants of this study are consistent with past research showing that while students acquire the necessary knowledge, they are not utilizing the information attained to improve their sleep. These results suggest that further research may be helpful to

determine what factors impede sleep hygiene knowledge from translating into behavioral changes.

Hypothesis 4A and 4B

Hypothesis 4A states that there would be a significant relationship between sleep anxiety and sleep quality. Specifically, it was stated that participants with higher levels of anxiety about sleep would have poorer sleep quality than individuals with lower levels of anxiety about sleep. This hypothesis was supported. The results show that as participants' anxiety about sleep increased their sleep quality decreased and vice versa.

Results are consistent with past research stating that individuals with higher levels of anxiety are more likely to report decreased sleep quality (Hall et al., 2008; Sadigh et al., 2014). College students face a variety of challenges related to increased independence, responsibility, relationships, financial strain, and academic challenges, which are likely to impact their sleep. For many students, this may result in fatigue and increased concerns about their lack of efficient sleep (Lichstein & Rosenthal, 1980), thus causing further anxiety, which may lead to a vicious cycle in which lack of sleep and subsequent anxiety related to decreased sleep will be exacerbated.

Hypothesis 4B states that there would be a significant relationship between sleep anxiety and sleep length. Specifically, it was hypothesized that participants with lower levels of anxiety about sleep would have longer sleep length, as measured by self-report and actigraphy data, compared to individuals with high levels of anxiety about sleep. This hypothesis was supported.

Previous research notes that anxiety not only impacts sleep quality, but that individuals reporting heightened stress will generally get less sleep (Hudd et al., 2000)

and report experiencing broken sleep throughout the night (Mezick et al., 2009). Forquer et al.'s (2008) study noted that 33% of their sample identified anxiety as a factor undermining their sleep. Students with higher stress levels have greater incidents of sleep disturbances and fatigue (Lee et al., 2013) as well as significantly less sleep (Fernández – Castillo, 2013). It is likely that increased arousal and rumination associated with increased anxiety may also make it more difficult to initiate and maintain sleep in addition to the factors mentioned above (Pillai et al., 2014). Anxiety can also be related to insomnia, which would impact participant's sleep length.

Hypothesis 5

Hypothesis 5 states that there would be a significant difference in fatigue between the groups as a result of the intervention. Specifically, it was predicted that participants in the treatment condition would have significantly lower fatigue at P-III than the control group. This hypothesis was not supported. The results indicated that there was no statistically significant interaction between participant group and time, nor was group a significant main effect on fatigue. However, there was a significant main effect of time on fatigue. These results indicate that the intervention did not impact perceived fatigue; however, some shared factor between participants in both groups appears to have resulted in a reduction of fatigue during the day. It may be that through use of actigraphy and sleep diaries, participants increased awareness of sleep length impacted their perceptions of fatigue or other sleep related concerns.

There are several possible explanations for the results of hypothesis 5. As mentioned previously, overall participants were sleeping an average of 7.75 hours per night, which is in the recommended range. It is possible that the use of actigraphy devices

synced to participants cell phones and/or maintaining a daily sleep log allowed participants to become more aware of their length of sleep. This knowledge of participants sleep length may have altered their perceptions of fatigue and beliefs that they were getting insufficient sleep at night. Previous studies indicated that individuals often have a false perception of being awake for extended periods throughout the night (Marano, 2003), which could lead them to believe they are experiencing broken sleep and poor sleep quality. If this perception was inaccurate and corrected through the use of actigraphy data, individuals' beliefs about daytime sleepiness and fatigue following broken sleep may dissipate. Additionally, it has been suggested that many maintain the idea that they should feel tired after their perception of insufficient restful sleep, which can lead to behaviors aimed at stimulating arousal, increasing energy, napping, or engaging in other activities that may later impact sleep (Buboltz et al., 2009). Participants' level of fatigue may also be impacted by factors that are unrelated to sleep such as physical health, activity level, or anxiety.

Hypothesis 6

Hypothesis 6 states that there would be a significant difference in insomnia symptoms following the intervention. It was hypothesized that participants receiving the SPEAK intervention would have significantly lower severity of insomnia than the control group. This hypothesis was not supported. The results indicated that there was no interaction between participant group and time, nor was group a main effect on insomnia. However, results did indicate a main effect for time on insomnia.

As mentioned previously, it is possible that students increased awareness of their sleep behaviors and sleep length altered their beliefs and perceptions of sleep difficulties.

Symptoms of insomnia include not only difficulties in initiating and maintain sleep, but also included evaluation of students' perceptions of sleep satisfaction, functional abilities, and quality of life as it relates to sleep behaviors. As previously stated, individuals' beliefs will play a role in their behaviors and perceptions of difficulties. It is likely that increased knowledge and awareness of their sleep length and sleep behaviors may have diminished perceptions of sleep difficulties and ameliorated concerns relating to negative consequences of insufficient sleep. Additionally, participant's average ISI scores at P-I was 8.94, which falls within the sub-threshold insomnia range. This indicates that while participants reported some sleep difficulties, they were not sufficiently intense and/or frequent to be indicative of clinical insomnia. Finally, participants were within the recommended length of sleep per night ($M = 7.75$) at baseline, thus diminishing participants' perception of necessity regarding changes related to sleep. The intervention might have been more effective on a clinically sleep-deprived sample.

Hypothesis 7

Hypothesis 7 states that an interaction existed between anxieties about sleep, sleep hygiene knowledge, and sleep hygiene practices. Specifically, it was hypothesized that participants with greater sleep hygiene knowledge and lower anxiety about sleep would show greater implementation of sleep hygiene practices. This hypothesis was not supported by the examination of anxiety about sleep as a moderator of the relationship between sleep hygiene knowledge and practices. While sleep hygiene knowledge did not account for any variance in sleep hygiene practices and anxiety about sleep accounted for 6.9% of variance in sleep hygiene practices, the interaction between the variables only accounted for an additional .1% of variance in sleep hygiene practices.

There are several explanations for these results. While there have been numerous studies indicating the impact of anxiety on sleep length and sleep quality (Morin & Epsie, 2003; Zawakzki et al., 2013), few studies have evaluated the role of anxiety specific to sleep related to sleep hygiene beliefs and practices. College students often struggle with transitional issues and anxiety relating to adjustment, new living situations, employment, financial concerns, and academic difficulties. With students experiencing multiple stressors, it may also be that anxiety specifically related to sleep is not perceived as a primary stressor and is therefore unlikely to impact the relationship between hygiene beliefs and practices. It may be that a measure of general anxiety that encompasses several areas would moderate the relationship between hygiene beliefs and practices. Participants were also found to have adequate sleep length ($M = 7.75$ hours per night). Additionally, there are also other potential variables that may impede implementation of sleep hygiene knowledge into practices including sleep locus of control, mental health concerns, motivation and perception of value relating to alteration of behaviors, or fatigue. Finally, participants were within the recommended length of sleep per night ($M = 7.75$) at baseline, which may limit anxiety about sleep and impact implementation of sleep hygiene practices.

Hypothesis 8

Hypothesis 8 states that an interaction existed between sleep beliefs, sleep length, and sleep quality. Specifically, it was hypothesized that participants with greater sleep length and healthier beliefs about sleep would report increased sleep quality. This hypothesis was not supported by the examination of sleep beliefs as a moderator of the relationship between sleep length and sleep quality. While sleep length accounted for

5.9% of variance in sleep quality and sleep beliefs accounted for an additional .2% of variance in sleep quality, the interaction between the variables indicated no additional variance in sleep quality.

These results are inconsistent with research finding that students' beliefs about sleep impacts motivation to initiate behavioral changes and perceived efficacy of interventions (Digdon, 2008; Machado et al., 1998). One possible explanation for the present results is that the SBS is not an adequate measure of participants sleep beliefs and instead is more consistent with factors of sleep hygiene knowledge. Measures specifically designed to assess personal beliefs about sleep rather than knowledge of sleep hygiene may yield better results. Sleep quality may also be impacted by a any number of variables, such as stress, medical conditions, dietary intake, as well as various combinations of factors. Also, at P-I participants demonstrated adequate sleep length ($M = 7.75$ hours per night) and marginally poor sleep quality, as indicated by PSQI scores that were only slightly above the clinical cutoff for poor sleep quality ($M = 6.25$) at P-I. It is possible that sleep beliefs are not a moderator of the relationship and that other variables such as those mentioned above, alcohol or other substances, technology use, or environment would moderate the relationship between sleep length and sleep quality. While participants in the treatment group were instructed to refrain from the use of technology, such as cellular phones, prior to bedtime and to silence notifications, compliance with this was not assessed.

Implications

Based on the results of this study, there are several implications to note regarding the state of sleep in college students, interventions to increase sleep length and sleep quality, and relationships between factors that may impact students' sleep.

While many studies mention sleep among college student as problematic (Bonnet & Arand, 2012; Lund et al., 2010; Stenzel, 2015), the present study suggests that sleep length may not be as problematic as suggested by past research. This sample averaged 7.75 hours of sleep per night prior to intervention, which is well within the seven to nine hours of sleep per night recommended by the National Sleep Foundation (2005).

However, although sleep length in this sample was adequate, their sleep quality, though only slightly above the cutoff, indicated poor sleep quality and that students sleep hygiene knowledge was below that of the reference sample (Adan et al., 2006), indicating that these students were not achieving restorative sleep and are less likely to be aware of behaviors that may impact their sleep despite achieving adequate sleep length.

Interestingly, actigraphy results indicated that overall, at baseline this sample spent approximately 51% of sleep each night in restful sleep. Results also indicated the sample as a whole experienced sub-threshold insomnia. The SPEAK program was created to promote sleep length and sleep quality, but student's were already achieving adequate sleep length. These results suggest that diverting attention to factors specific to sleep quality may have a greater impact than interventions aimed at increasing sleep length. The intervention should also be evaluated in students with identified sleep difficulties.

This study also implies that counselors should assess sleep length and sleep quality of students to first determine if there are sleep difficulties and then use that

information to determine if an intervention is necessary. Also, since participants failed to implement sleep hygiene practices even after acquiring sleep hygiene knowledge, this may illustrate the difficulties associated with making behavioral changes, especially within a population that is plagued by variable daily schedules, increased anxiety, and pressure to succeed academically. This implies that universities may need to assist in promoting healthy sleep behavior at an institutional level. For example, universities could provide more consistent start-end times for courses during the week and limit night classes that meet once per week and do not end until 9:30 at night. They could also alter hours of operation for the gym, library, or food establishments in order to promote good sleep hygiene practices.

Results of the intervention suggest that, overall, it was not effective in ameliorating sleep difficulties or increasing sleep length or sleep quality. There are many factors that can impact a person's sleep, many of which can be modified. However, it is important that information be delivered in a way that is seen as practical and personally relevant to each participant, which can be difficult within a group setting. The importance of applying information should also be emphasized to participants, as they are able to acquire knowledge relating to sleep hygiene, but did not perceive a need or ability to change their behaviors accordingly. Changes in student perceptions and needs regarding sleep may have changed over time and an assessment of present needs should be conducted to determine what types of difficulties students are presently experiencing that can be targeted through intervention. Additionally, with technological advancements and increased use of social media, other methods of intervention should be evaluated. Students spend a disproportionate amount of time on cellular phones, Internet, and social

media and therefore may be more engaged if an intervention was delivered through a technological platform in which are already engaged, such as Facebook or other forms of social media.

Research has identified many factors that impact sleep. Although anxiety about sleep and sleep beliefs were evaluated as potential moderators of sleep related variables, neither was found to be significant. This further illustrates that many variables may be impacting sleep and their relationship to one another should be further evaluated. Specifically, factors that may moderate the relationship between sleep hygiene knowledge and practices should be assessed as this study, as well as past research (Holbrook, 1994), has demonstrated that acquisition of sleep hygiene knowledge does not always impact sleep hygiene behaviors. The reason for this remains unknown and this gap of knowledge needs to be filled.

While the intervention did not improve sleep-related factors, results regarding fatigue, insomnia, sleep length, and sleep quality did have a significant main effect for time. This signifies that a shared factor between the treatment and control groups would account for changes in these variables and not the intervention. It may be that students' increased awareness of sleep length increased by tracking sleep times via sleep diaries or by using the application syncing participants' actigraphy data. This heightened awareness may have been sufficient to alter beliefs and perceptions regarding insomnia and fatigue as well as promote increased sleep length and sleep quality.

Finally, while the use of actigraphy can be helpful, particularly in evaluating treatment outcomes, these results support that use of self-report data is an efficient, reliable, and valid form of data collection that is comparable to data obtained through

objective means. Many studies utilize self-report data as it is more cost effective, requires less time, and is able to be utilized by larger numbers of participants concurrently. While some questions of reporting bias have been raised in past research (Jean-Louis et al., 1999; Verbeek et al., 2001), this study supports that self-report data is a valid means of assessing sleep length.

Limitations

While the present study has many strengths, there are also several limitations that may have impacted the results. First, the sample size was relatively small ($N = 87$) and consisted of primarily Caucasian (82.8%) and female (68.4%) participants. Additionally, all participants were recruited from a medium sized, public Southern university, thus the generalizability of the results is limited due to limited variability in geography and demographic characteristics of the sample. Additionally, this sample was not sleep deprived and reported mild sleep difficulties at baseline, which likely impacted the efficacy of the intervention and motivation to initiate behavioral changes to improve sleep length and sleep quality.

Second, there may be difficulties relating to the study design and measures utilized. For example, the ASPQ (Tang & Harvey, 2004) is a relatively new measure that has limited empirical support and was not normally distributed among the sample, thus requiring the use of non-parametric statistics to analyze data. Also, participants completed the same measures on multiple occasions, which could result in biased results due to familiarity with questions and potential difficulties related to test-retest reliability. Also, participants were not randomly assigned to groups and, instead, signed up for a

designated date/time in which they were able to attend with groups randomized to a treatment or control condition.

Third, there were no exclusionary criterion for participants, which may have affected the motivation and necessity of the intervention for participants. If students do not perceive difficulties in their sleep, they are unlikely to implement behavioral changes that would increase their sleep length and/or sleep quality. The average sleep length at baseline was 7.75 hours of sleep per night and baseline PSQI scores were only slightly above the cutoff for poor sleepers. If participants did not believe their sleep was negatively impacted, they would be unlikely to apply knowledge acquired during the intervention.

Fourth, follow-up data were collected two weeks following the intervention. This may not be a sufficient length of time to implement changes in sleep patterns and result in significant gains in sleep length or sleep quality. Changes to sleep behaviors and perceptions of changes related to sleep are often a slow process and may not be noticeable or significant only two weeks after attempting to initiate additional behaviors to promote sleep. Allowing for a longer follow-up period, such as six-weeks as found in Brown et al.'s (2006) study, would likely provide sufficient time to evaluate behavioral changes and impact.

Fifth, participant feedback regarding their perception of the intervention, strengths or weaknesses, utility, or applicability to the individual participant was not evaluated. This information may have provided additional information regarding specific factors that impact college students and areas to highlight in future research. Additionally, several of the analysis revealed a significant main effect for time, which may be

explained by the use of the sleep diary or actigraphy device. Participants wore the wrist actigraphy device each day and night and would sync data to an application on their smart phone, which allowed them to access the information. It would have been helpful to determine how many participants monitored or reviewed the data and their perceptions of sleep based on the actigraphy data. By assessing the frequency and perception of actigraphy data, it may have provided additional insight into the results of the study as well as providing information about how students' perceptions of sleep length intersected with their actual sleep length.

Sixth, it would likely have been beneficial to gather information about implementation of sleep hygiene practices and problem solving related to any perceived difficulties. This may have included a discussion with students following the presentation of psychoeducational sleep information regarding personally relevant factors and provide a forum for group discussion to brainstorm solutions to barriers related to implementation of the newly acquired information. This may have also been assessed at P-III by evaluating if participants attempted to implement changes related to the information presented, rationale for their response, and factors that may impede or promote behavioral changes.

Suggestions for Future Research

Future research endeavors relating to a psychoeducational sleep intervention may want to correct for the above-mentioned limitations. Research should be conducted with a diverse group of participants, including varying geographic locations, age, gender, ethnicity, and college majors in order to increase generalizability of results. Also, utilizing exclusionary criteria would allow for the intervention to be provided to those

that have identified difficulties with sleep. The majority of this sample reported adequate sleep length and scores of sleep quality that was only slightly above the cutoff for identifying poor sleepers. Interventions for sleep provided to individuals that are not reporting significant difficulties with sleep are not likely to achieve maximum benefit. Future research should aim to recruit participants that have identified sleep problems that may benefit from intervention in order to established intervention efficacy.

There are also suggestions regarding research design for sleep intervention outcome studies. It would be beneficial to have a longer time frame to assess sleep factors post-intervention. Making behavioral changes can take time and two-weeks following sleep knowledge acquisition may not be a sufficient length of time to initiate these behaviors and notice changes that may have occurred. Additional studies may consider assessing participants six-weeks post intervention, which has been found to be provide adequate time for participants to make behavioral changes and become aware of outcomes associated with those changes, such as decreased fatigue or increased sleep quality (Brown et al., 2006). Also, while participants in the study were not aware of their group type, random assignment was not utilized as students were instructed to sign up for the time slot in which they were able to participate. In order to have a true experimental design, which is ideal for outcome research, studies would benefit from design that allows for random assignment of all participants.

Future research may also want to further assess participant feedback, particularly their perception of sleep and use of sleep logs and actigraphy. Participants using actigraphy devices had access to information about their sleep, including sleep length, sleep onset, and wake times, as well as activity level, including distance walked and

calories burned, each day. While participants were not required to access this information and activity data was not collected as part of this research study, some spontaneously reported frequently viewing this information and were surprised at the results. It is unclear if or how often participants were viewing this information and if it impacted their behaviors. Future research should gather information about discrepancies or confirmation of students' perception of sleep length prior to participation and after completing sleep logs or actigraphy. Additionally, assessing how this information may have impacted their behaviors regarding sleep or utilizing actigraphy data that is not accessible to participants would be helpful.

Additionally, it may be beneficial to assess additional variables that may impact the relationships between sleep hygiene knowledge and sleep hygiene practices as this study aligns with past research indicating that while sleep hygiene is modifiable and can impact sleep, sleep hygiene alone is not enough (Morgenthaler et al., 2007). In order to impact sleep length and sleep quality, sleep hygiene knowledge must be translated into sleep hygiene practices. It may be helpful to assess locus of control in participants, which may impact their motivation, expectations, and outcomes related to sleep difficulties and behavioral changes. Additional variables may include technology use and perceived necessity of sleep changes and/or increased sleep quality.

Another suggestion for future research is to add a problem-solving component to allow participants to share difficulties or suggestions relating to implementation of sleep difficulties. This may be done as a group, which would also allow for additional consideration, engagement, and integration of information into their personal lives, which may allow the information to be more personally meaningful and accessible to students.

This would also be likely to increase motivation for change by providing practical means for changing behaviors as well as recognition of sleep problems as common and amendable.

Finally, due to advancements and utilization of technology and social media use today, various media of sleep interventions should be considered. This study utilized a face-to-face intervention, but information distributed through video, e-mail, Facebook, or Internet may prove particularly helpful, especially within the college population. In addition to engaging platforms commonly utilized by college students presently, this would also allow for increased flexibility to accommodate student's variable schedule and provide them with information that can be accessed repeatedly. It would also be helpful to assess potential benefits of providing reminders of additional information to participants via text or e-mail following intervention to increase awareness and promotion of healthy sleep behaviors. Finally, use of technology to provide interventions would also allow for random assignment of all participants.

Summary

The effectiveness of interventions in college students has yielded mixed results (Bootzin & Epstein, 2000; Calvert, 2012, National Sleep Foundation, 2006a; Ritterband et al., 2012; Taylor et al., 2014). The purpose of the present study was to extend knowledge relating to sleep by evaluating the efficacy of a sleep intervention program on undergraduate college students incorporating sleep hygiene, stimulus control, and cognitive factors related to sleep. Also, while many studies have evaluated sleep interventions in college students, few have integrated the use of actigraphy and self-report measures in this population. Additionally, anxiety and sleep beliefs were examined

as potential factors that may impact the integration of knowledge into practices that promote sleep.

The results of the present study indicated that the intervention was not effective at increasing sleep length or sleep quality. Interestingly, while the interaction between group and time was not significant, time was found to effect sleep length, sleep quality, fatigue, and insomnia. This indicated that an unaccounted for variable shared among both groups accounts for the decrease of insomnia and fatigue as well as increases in sleep length and sleep quality. Additionally, results indicated that sleep beliefs did not moderate the relationship between sleep length and sleep quality nor did anxiety about sleep moderate the relationship between sleep hygiene knowledge and sleep hygiene practices.

In conclusion, results of the study contribute to current literature by highlighting changes in college students sleep length as well as evaluation of multiple variables and their relationship to sleep. Also, application of objective sleep data to interventions with college students is sparse, thus this study provides evidence that self-report data is significantly correlated with actigraphy data. Finally, this study suggests that variables other than anxiety about sleep and sleep beliefs may moderate the relationship between sleep variables and should be explored further,

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APPENDIX A

Human Use Committee Approval



LOUISIANA TECH UNIVERSITY

MEMORANDUM

OFFICE OF UNIVERSITY RESEARCH

TO: Dr. Walter Buboltz and Ms. Danielle Newman
 FROM: Dr. Stan Napper, Vice President Research & Development
 SUBJECT: HUMAN USE COMMITTEE REVIEW
 DATE: December 10, 2015

In order to facilitate your project, an EXPEDITED REVIEW has been done for your proposed study entitled:

**"College Life: Education, Sleep and Lifestyles
of College Students"**

HUC 1381

The proposed study's revised procedures were found to provide reasonable and adequate safeguards against possible risks involving human subjects. The information to be collected may be personal in nature or implication. Therefore, diligent care needs to be taken to protect the privacy of the participants and to assure that the data are kept confidential. Informed consent is a critical part of the research process. The subjects must be informed that their participation is voluntary. It is important that consent materials be presented in a language understandable to every participant. If you have participants in your study whose first language is not English, be sure that informed consent materials are adequately explained or translated. Since your reviewed project appears to do no damage to the participants, the Human Use Committee grants approval of the involvement of human subjects as outlined.

Projects should be renewed annually. *This approval was finalized on December 10, 2015 and this project will need to receive a continuation review by the IRB if the project, including data analysis, continues beyond December 10, 2016.* Any discrepancies in procedure or changes that have been made including approved changes should be noted in the review application. Projects involving NIH funds require annual education training to be documented. For more information regarding this, contact the Office of University Research.

You are requested to maintain written records of your procedures, data collected, and subjects involved. These records will need to be available upon request during the conduct of the study and retained by the university for three years after the conclusion of the study. If changes occur in recruiting of subjects, informed consent process or in your research protocol, or if unanticipated problems should arise it is the Researchers responsibility to notify the Office of Research or IRB in writing. The project should be discontinued until modifications can be reviewed and approved.

If you have any questions, please contact Dr. Dr. Mary Livingston at 257-2292 or 257-5066.

A MEMBER OF THE UNIVERSITY OF LOUISIANA SYSTEM

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